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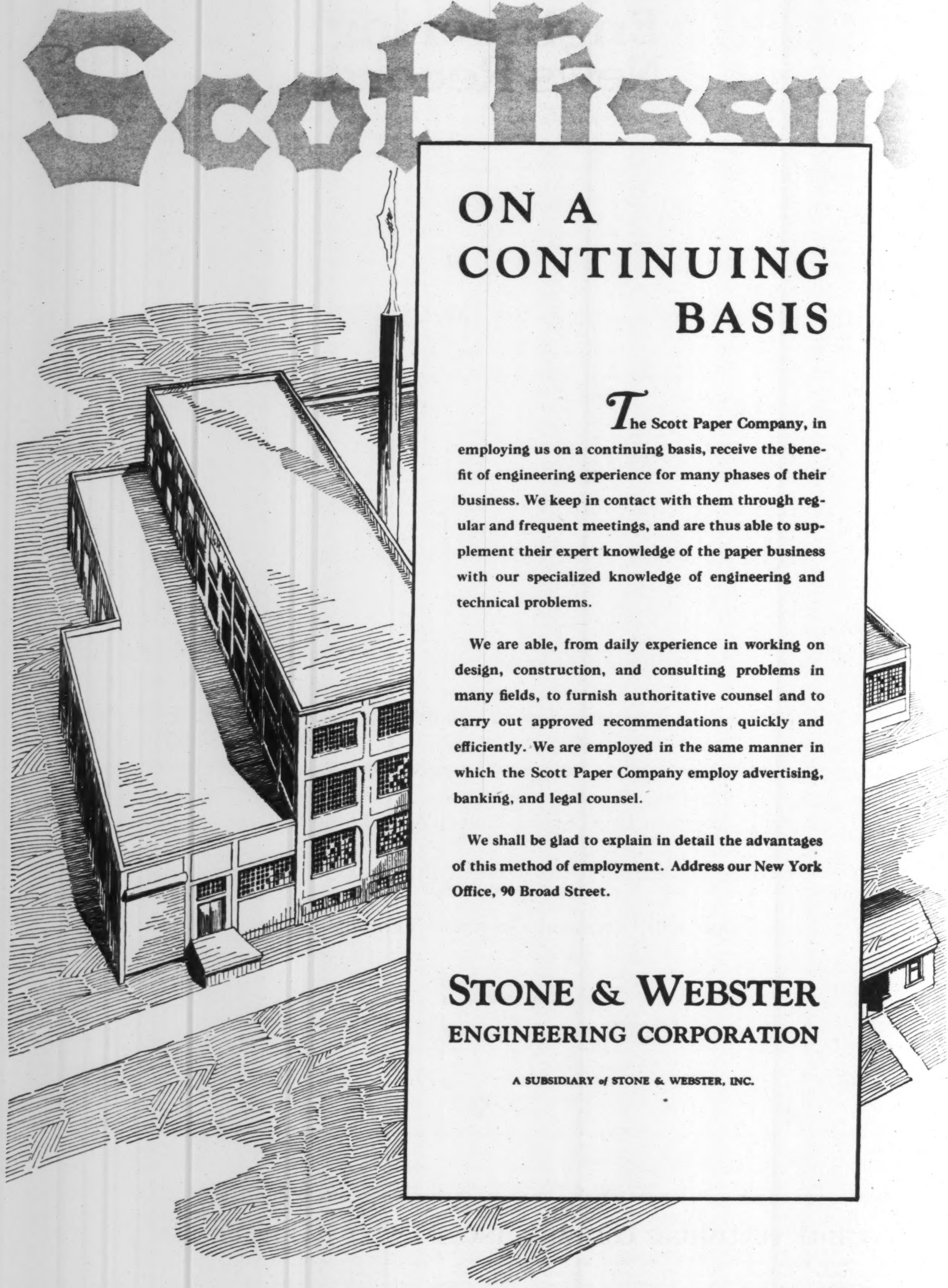

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The Cost of Federal Public Works

A SUMMARY of federal construction expenditures by years and agencies since 1920 and estimated future expenditures for six years from 1933 comprise the subject matter of this article. The variety of federal construction operations and the spread and magnitude of federal expenditures for construction are best set forth by unembellished factual statement. The figures and charts given are authoritative, being compiled during the year from reports made by the agencies doing federal construction in compliance with the act of 1931, which created the Federal Employment Stabilization Board for this and other purposes stated in the article. The director of the board is D. H. Sawyer, and the engineer is Fred E. Schnepfe. Their work provides the first complete analysis of federal construction activities and expenditures that has been generally available to engineers.

IN 1931 the various construction agencies of the federal government spent $476,000,000 for construction and for maintenance repairs and alterations classified as construction. This is a larger amount than was spent by any other public or private agency. No other agency does such a wide variety of construction. What federal agencies direct this outlay? What are the kinds of construction performed? In what manner have construction expenditures developed? What are the estimates of the bureaus for future expenditures?

Answers to these decidedly interesting questions have been determined during the past year by the Federal Employment Stabilization Board created by act of Congress and approved by the President Feb. 10, 1931. Primarily the objective of this board is the advance planning of federal construction, but it has the coordinate functions of collecting and analyzing statistics on construction and of assisting states, counties and cities in encouraging long-range planning programs. It is in compliance with these functions of statistician and agency for advance planning of federal construction that the data given in this article have been developed.

Federal construction agencies

The basic organization of the government is by ten departments and numerous independent agencies. All of the departments have within their jurisdiction bureaus that design and construct public works or are concerned in their maintenance and repair. This is also true of some of the independent agencies. The department construction bureaus fall into two categories: (1) those which have little construction of their own but act as a service organization for other bureaus that do construction; and (2) those having actual construction programs. The most important example of the purely service bureaus is the office of the supervising architect of the treasury. The truly construction bureaus are : (1) those that have design and construction as their major function; and (2) those that have construction as an incidental to administrative functions.

All of these agencies have their principal offices in Washington, but the work done by many of them requires decentralization of direction calling for branch offices, warehouses, repair plants and other facilities. Agencies notable for decentralized direction are the engineer corps of the army doing flood-control and river and harbor work and the bureau of reclamation. Some of these agencies and notably the ones just named are large owners of construction equipment and carry on construction by force account.

A notable fact is the wide variety of construction performed and the many agencies that are planning and performing the same character of work. The kinds of construction that the various agencies carried on in 1931 are given in Table II.

The detail of administration and methods of the various agencies have not been greatly standardized. Management and procedure are different for each agency. This is true of the headquarters activities in Washington, of the field organizations, of the types of

TABLE I—PAST EXPENDITURES FOR FEDERAL CONSTRUCTION 1920-1931, ESTIMATED EXPENDITURE FOR 1932 AND EXPENDITURES PLANNED IN ADVANCE FROM 1933 TO 1938, AS REPORTED BY DEPARTMENT BUREAUS AND INDEPENDENT AGENCIES

(ALL AMOUNTS IN THOUSANDS OF DOLLARS)

Department or Independent Agency	Past Expenditures												Est. Expend.	Advance Planning					
	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938
Agriculture:																			
Departmental	53	21	23	26	23	26	26	26	26	30	24	57	64	15	15	12	12	16	16
Agricultural engineering															10	10	5		
Animal industry	25	22	45	32	23	21	27	24	25	104	67	85	89	381	320	150	115	7	1
Biological survey		2	4	4	15	20	22	13	31	68	109	260	15	177	560	459	432	165	152
Chemistry and soils	4							5	6	10		1	40	15	10	13	10	13	10
Dairy industry						28	31	20	27	26	54	74	49	99	68	51	39	27	11
Entomology										6	16	8	7	15	22	7	7	7	7
Experiment stations	23	20	22	30	22	15	12	18	16	40	26	31							
Food and drug administration															40				
Forest service	8,224	9,352	7,251	13,005	18,108	20,277	18,499	17,043	15,631	17,318	15,639	28,980	28,051	25,899	25,135	24,929	24,689	24,474	24,390
Plant industry	72	59	54	70	81	63	108	88	94	158	266	256	174	130	130	130	130	130	130
Plant quarantine	26	30	3	44		2	5	6	1	26	34	37	15	9	9	9	9	9	9
Public roads	20,341	57,463	89,947	71,605	80,448	97,473	89,362	82,978	82,514	85,992	80,639	161,331	226,791	125,577	109,000	109,000	109,000	109,000	125,000
Weather bureau	12	4	10	16	16	15	12	50	8	9	58	16	53	10	14	14	14	14	15
Total	28,781	66,973	97,359	84,832	98,736	117,938	108,105	100,271	98,380	103,786	96,931	191,136	255,348	152,325	135,332	134,785	134,462	133,861	149,740
Commerce:																			
Aeronautics								460	1,747	2,643	2,232	3,637	2,119	1,680	1,377	1,361	787	487	487
Coast and geod. survey	74	68	68	73	69	74	76	88	84	281	270	323	91	94	378	407	117	744	111
Fisheries	229	132	56	64	58	92	64	90	171	164	423	285	554	395	374	440	534	734	1,194
Lighthouses	2,255	2,364	2,374	2,223	2,182	1,820	1,882	2,217	2,462	2,946	3,368	2,983	7,176	3,319	3,028	3,249	3,191	3,134	3,168
Mines	59	37	75	143	21	83	250	82	126	538	143	68	42	43	607	687	657	157	99
Navigation	16	20	9	7	22	14	15	15	16	13	13	65	12	10	47	12	10	47	10
Radio division										50	30		2	42	2	2	2	2	2
Standards	18	18	18	18	18	18	18	18	268	40	92	47	391	41	506	201	191	176	341
Total	2,651	2,640	2,600	2,526	2,371	2,101	2,305	2,970	4,873	6,675	6,572	7,409	10,386	5,624	6,318	6,360	5,488	5,481	5,410
Interior:																			
Alaska R.R.	5,556	9,506	6,021	5,257	2,443	1,666	1,882	1,558	1,456	1,230	1,534	1,012	1,179	1,135	1,130	1,104	1,078	1,066	1,043
Col. Inst. for Deaf	14	26	15	12	16	15	19	17	14	14	15	15	17	17	132	168	151	227	197
Education	63	12	37	23	40	49	70	66	35	62	87	263							
Freedmen's Hospital					60	19	50			252		155	174			60			
Geolog. survey				10	1	1	12	4	10	32	65	109	100	231	231	231	231	231	231
Howard University	32	33	234	43	60	178	400	30	42	39	52	848	1,097	765	1,147	37	37	37	37
Indian affairs	2,469	2,185	1,843	1,978	2,654	2,283	1,156	2,129	4,767	5,105	3,908	4,649	7,032	3,260	6,068	5,695	4,482	3,731	3,100
Nat'l park service	389	585	813	695	1,047	1,923	2,115	2,586	3,580	3,376	5,915	8,638	9,144	9,348	8,895	8,945	8,973	8,883	8,853
Reclamation	5,438	7,765	6,486	9,577	10,303	9,385	8,017	6,606	8,236	9,190	9,904	13,917	23,500	45,047	73,350	76,720	72,784	71,845	76,555
St. Elizabeth's Hospital	65	130	115	229	147	320	113	120	125	685	625	835	1,435	1,370	535	1,300	1,660	1,600	450
Virgin Islands				4	12	8	122	52	20	34	65	38	65	201	88	84	84	82	10
Total	14,026	20,243	15,563	17,826	16,781	15,848	14,316	13,169	18,286	20,019	22,171	30,477	43,742	61,374	91,575	94,344	89,479	87,702	90,475
Justice:																			
Court of Claims																			
National Training School for Boys														5					
Prisons														129	348	180	125	165	130
Prohibition	351	221	198	179	356	349	1,223	1,426	341	177	1,031	1,319	6,639	350	350	350	350	350	350
U. S. Marshals — Alaska		2	5	5	7	6	8	8	9	9	9	2	2	2	3	3	3	3	3
Total	351	223	203	184	362	355	1,231	1,433	350	186	1,041	1,321	6,641	486	701	533	478	518	483
Labor:																			
Immigration	179	182	163	154	425	110	120	60	59	274	50	104	324	50	691	419	78	77	95
Navy:																			
Yards and docks	57,176	29,346	23,960	16,226	12,012	10,410	10,456	10,286	13,934	16,774	16,276	22,848	25,216	18,450	19,500	19,000	18,500	18,500	18,500
Post Office:																			
Departmental														12	12	12	12	12	12
Post offices	2,934	2,924	2,382	1,664	2,086	3,226	2,051	3,076	5,478	6,949	8,197	18,436	45,719	17,518	44,606	37,584	21,348	4,775	220
Total	2,934	2,924	2,382	1,664	2,086	3,226	2,051	3,076	5,478	6,949	8,197	18,436	45,719	17,530	44,618	37,596	21,396	4,787	231
State:																			
Foreign service buildings														1,434	160	70	70	70	70
Gorgas Memorial Commission										8	10	3		50	50	50	50	50	50
Total										8	10	3		1,484	210	120	120	120	120

Treasury:																			
Coast Guard	680	891	816	864	4,757	1,476	6,515	4,377	7 873	3,338	6,282	6,642	4,990	5,872	6,437	6,144	3,654	3,004	2,099
Customs	....	....	....	24	32	104	74	6	82	154	18	78	95	....	....	....	....	....	....
Engrav. and ptg.	....	38	32	37	35	36	21	53	54	77	105	123	75	75	75	75	75	75	75
Pub. Health Serv.	146	....	....	47	62	50	74	71	107	165	45	325	133	235	197	203	173	165	160
Supervising Arch.																			
Departmental (Treas.)	....	....	....	....	....	....	....	....	....	....	....	....	....	62	65	67	67	67	67
Fed. office bldgs.	1,480	3,271	439	407	320	325	305	481	772	1,068	996	3,298	26,942	7,377	15,580	10,213	8,613	3,988	2,473
Post offices	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Pub. Health Serv.	2,494	2,407	655	1,116	858	483	400	602	740	1,014	1,527	3,204	11,489	1,040	1,790	1,640	1,010	860	445
U. S. Govt. bldgs., D .C.	....	....	....	....	....	....	....	7	239	3,545	16,046	6,502	....	4,200	21,150	10,750	8,000	3,000	550
Total	4,800	6,606	1,942	2,499	6,063	2,474	7,388	5,598	9,867	9,362	25,019	20,176	43,725	18,860	45,294	29,092	21,592	11,159	5,869
War:																			
Air Corps	782	1,692	287	254	259	812	294	1,515	1,144	1,531	1,878	3,167	1,700	....	....	....	....	....	....
Chem. Warfare Serv	74	98	21	2	18	24	15	31	57	50	36	29	38	....	....	....	....	....	....
Corps of Engrs.:																			
Board Road Commissioners, Alaska	132	350	427	556	730	775	1,014	890	860	997	1,256	908	1,064	1,030	1,230	1,230	1,230	1,230	1,230
Flood control	9,545	12,856	10,659	9,619	8,243	11,792	10,731	11,978	14,279	24,820	26,446	37,878	40,377	36,000	36,000	36,000	36,000	36,000	33,460
Rivers and harbors	46,705	55,542	37,061	44,806	68,682	71,921	60,231	56,454	59,615	59,853	76,399	82,994	95,495	75,000	68,370	59,211	54,804	50,892	45,983
Sea coast defences	2,607	3,065	1,294	1,341	881	837	690	651	842	1,122	954	943	....	....	....	....	....	....	....
Militia bureau	....	....	....	....	....	1,099	1,167	1,296	1,257	815	967	1,377	295	273	778	707	706	680	644
Ordnance	1,692	1,611	1,454	610	598	662	728	750	1,022	2,016	2,530	1,560	1,284	....	....	....	....	....	....
Quartermaster Corps	26,381	25,286	8,345	4,462	4,772	5,094	7,095	12,935	12,533	19,093	17,685	28,736	27,313	25,834	28,180	27,328	25,874	25,807	28,133
Signal Corps	431	277	356	399	1,022	1,178	444	407	372	519	579	812	....	....	....	....	....	....	....
Total	88,049	100,775	59,905	62,047	85,205	94,195	82,409	86,907	91,982	110,815	128,730	158,403	167,566	138,138	134,558	124,476	118,614	114,608	109,451
Independent Offices:																			
Arch. of Capitol	....	....	....	....	....	....	....	....	....	....	....	....	....	9,393	5,695	4,168	1,481	1,301	86
Arlington Memorial Bridge Com.	....	....	....	....	....	....	356	1,456	1,944	2,370	2,672	1,011	1,368	1,000	1,000	750	....	....	....
Bound. Com. Alaska and Canada	18	10	18	8	1	1	2	1	14	13	11	9	13	17	17	17	17	17	17
Bound. Com. Mexico	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Columbia Hosp. for Women	....	....	....	....	....	....	....	....	....	....	....	....	....	3	3	3	3	3	3
Geo. Rogers Clark Sesq.	....	....	....	....	....	....	....	....	....	....	....	....	....	500	....	....	....	....	....
Gov't Printing Office	18	112	171	74	67	85	50	59	34	17	146	121	200	275	170	170	170	170	170
Inland Waterways Com	3,671	2,819	1,149	1,066	654	1,470	1,584	2,877	1,661	4,170	2,018	3,883	1,365	1,310	2,053	2,375	2,428	2,495	1,163
Mt. Rushmore Memorial	....	....	....	....	....	....	....	....	....	....	....	....	....	75	75	100	100	....	....
Nat'l Adv. Com. for Aeronautics	47	37	48	34	5	46	124	62	65	69	798	312	3	87	47	117	87	87	77
Panama Canal	2,040	2,272	847	857	1,330	1,755	2,305	3,750	3,210	3,334	2,997	4,722	5,767	8,503	8,174	8,615	4,951	5,499	2,182
Panama Railroad	3,259	3,788	1,063	787	920	935	1,144	960	1,644	1,282	1,473	1,301	1,263	875	2,025	1,400	1,700	2,446	1,375
Porto Rico Hurricane Relief	....	....	....	....	....	....	....	....	....	203	1,346	1,027	1,224	....	....	....	....	....	....
Pub. bldgs. and pub. parks	194	257	276	253	219	282	522	446	995	578	705	1,544	1,409	1,029	1,560	320	860	275	315
Smithsonian Institute	17	14	21	18	14	14	20	73	106	47	245	94	70	5,328	17,331	5,383	183	135	135
U. S. Shipping Board	....	....	....	....	397	1,652	1,316	1,141	766	634	475	348	426	185	185	185	185	185	185
Veteran's Admin	....	....	481	362	111	8,243	6,275	8,453	8,727	6,708	10,200	11,200	12,500	18,542	11,227	6,270	7,595	7,270	5,515
Total	9,265	9,310	4,072	3,459	3,718	14,483	13,698	19,278	19,165	19,426	23,087	25,572	25,607	47,120	49,561	29,872	19,758	19,882	11,221
Grand total	208,212	239,223	208,149	191,417	227,760	261,142	242,079	243,048	262,373	294,275	328,083	475,884	624,273	470,039	542,191	490,256	445,800	410,868	403,266

work undertaken, of the fiscal and accounting systems and of many other phases reaching from congressional action to the completion of construction.

Construction expenditures

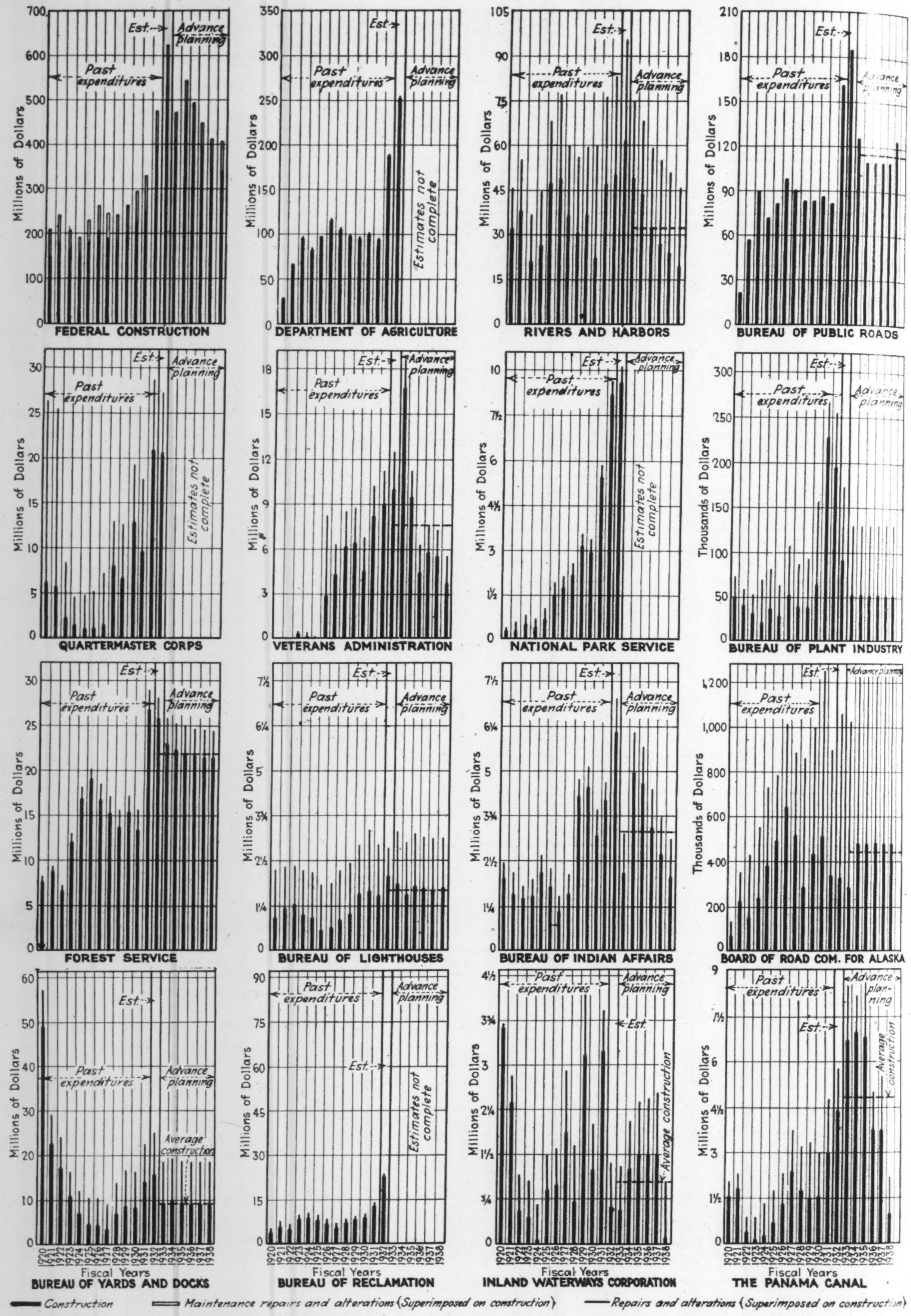
As stated, the federal expenditures for construction in 1931 were nearly $476,000,000. This money was spent by 50 department bureaus and 12 independent agencies. There are now existing (1932) 82 bureaus and offices with authority to carry on construction or to design for construction. A few of these organizations, such as the Arlington Memorial Bridge Commission, may be regarded as temporary agencies for federal construction, but most of them are permanent bodies dating back many years. In the accompanying listing (Table II) of these bureaus and their expenditures the records are carried back only to 1920. The growth of construction expenditures in this period, as given in this table, is shown graphically on the group of charts. A peak in 1931 is apparent as the result of the extensive undertakings in that year to relieve unemployment by public-works construction.

The mounting of construction expenditures indicated by the charts is paralleled by a yearly climb of expenditures in nearly every bureau doing construction, although the bureau curves are naturally more irregular. Several of these department and bureau charts are shown. These have been selected to include bureaus doing both large and small volumes of construction, those generally known to engineers for this activity and some that are rarely thought of by engineers as federal construction agencies. The charts in connection with the tabulated expenditures leave very little to be explained further regarding federal construction agencies and their expenditures.

These expenditures include the cost of maintenance and repairs as well as new construction. In normal years the upkeep items aggregate about $60,000,000. In each agency they involve a personnel for administration. In most instances the work is done by bureau forces, which involves ownership of equipment by the bureaus. New construction is performed by contract, by bureau forces or by a combination of the two methods, according to the policy of the bureau. Equipment ownership in some instances represents very large bureau investments.

Authorizations and appropriations

The conception of new construction enterprises arises from two sources: departmental and congressional. The construction agencies charged with administering functions created by Congress are continually alert to foretell those things that are necessary in the conduct of their affairs. With this knowledge they anticipate their needs


FEDERAL CONSTRUCTION
Millions of Dollars
0 100 200 300 400 500 600 700
Past expenditures
Est.
Advance planning
DEPARTMENT OF AGRICULTURE
Millions of Dollars
0 50 100 150 200 250 300 350
Past expenditures
Est.
Advance planning
Estimates not complete
RIVERS AND HARBORS
Millions of Dollars
0 15 30 45 60 75 90 105
Past expenditures
Est.
Advance planning
BUREAU OF PUBLIC ROADS
Millions of Dollars
0 30 60 90 120 150 180 210
Past expenditures
Est.
Advance planning
QUARTERMASTER CORPS
Millions of Dollars
0 5 10 15 20 25 30
Past expenditures
Est.
Advance planning
Estimates not complete
VETERANS ADMINISTRATION
Millions of Dollars
0 3 6 9 12 15 18
Past expenditures
Est.
Advance planning
NATIONAL PARK SERVICE
Millions of Dollars
0 1½ 3 4½ 6 7½ 10
Past expenditures
Est.
Advance planning
Estimates not complete
BUREAU OF PLANT INDUSTRY
Thousands of Dollars
0 50 100 150 200 250 300
Past expenditures
Est.
Advance planning
FOREST SERVICE
Millions of Dollars
0 5 10 15 20 25 30
Past expenditures
Est.
Advance planning
BUREAU OF LIGHTHOUSES
Millions of Dollars
0 1¼ 2½ 3¾ 5 6¼ 7½
Past expenditures
Est.
Advance planning
BUREAU OF INDIAN AFFAIRS
Millions of Dollars
0 1¼ 2½ 3¾ 5 6¼ 7½
Past expenditures
Est.
Advance planning
BOARD OF ROAD COM. FOR ALASKA
Thousands of Dollars
0 200 400 600 800 1,000 1,200
Past expenditures
Est.
Advance planning
BUREAU OF YARDS AND DOCKS
Millions of Dollars
0 10 20 30 40 50 60
Past expenditures
Est.
Advance planning
Average construction
BUREAU OF RECLAMATION
Millions of Dollars
0 15 30 45 60 75 90
Past expenditures
Est.
Advance planning
Estimates not complete
INLAND WATERWAYS CORPORATION
Millions of Dollars
0 ¾ 1½ 2¼ 3 3¾ 4½
Past expenditures
Est.
Advance planning
Average construction
THE PANAMA CANAL
Millions of Dollars
0 1½ 3 4½ 6 7½ 9
Past expenditures
Est.
Advance planning
Average construction
1920 1921 1922 1923 1924 1925 1926 1927 1928 1929 1930 1931 1932 1933 1934 1935 1936 1937 1938
Fiscal Years
Construction
Maintenance repairs and alterations (Superimposed on construction)
Repairs and alterations (Superimposed on construction)

and seek authorization that may later bring about the appropriation of money.

Certain bureaus are granted blanket authorization by Congress, and this entails no further action than the approval of the heads of the departments for their expenditures. Others require specific authorization, which often carries a limit of cost by Congress.

The construction agencies as well as all other bureaus of the government present their requests for money to the director of the bureau of the budget after approval by their departments or independent agencies. The budget bureau examines these requests, holds hearings and finally presents its consolidated report to the President, who transmits this to Congress for such action as it may elect to take.

The appropriation committee of the House of Representatives examines requests, holds hearings and finally brings out its report. When the committee has reached a conclusion on the departmental or independent establishment measure, it is transmitted to the House for action. Following action by this body, the bill is sent to the Senate, which refers the subject to the appropriation committee. After consideration by that group, often assisted by hearings, it is sent back to the Senate for its action. Following this, if there is disagreement between the House and Senate, a joint committee is delegated to reconcile differences of opinion. Subsequent action by both the House and the Senate follow, and the complete bill is transmitted to the President for his consideration.

It will be seen from this that appropriations pass through many phases, all designed to be helpful in granting funds for logical purposes.

In some instances bureaus are given lump-sum amounts, and they in turn allocate this to definite projects.

Planning ahead

The fundamental purpose of the act under which the data presented have been assembled is stated in its title as: "An act to provide for the advance planning and regulated construction of public works for the stabilization of industry and for aid in the prevention of unemployment during periods of business depression." Advance planning data are therefore an essential part of the tabulation and charts presented. These data are as given by the several agencies in compliance with the law that requires them: (1) to prepare a six-year advance plan with estimates showing projects allotted to each year; (2) to keep the six-year plan up to date by annual revision; and (3) to prepare a program for prompt commencement and execution of an expanded program at any time.

It is the duty of the Federal Employment Stabilization Board to cooperate with the construction agencies of the

TABLE II—TYPICAL ITEMS OF CONSTRUCTION AND MAINTENANCE ACTIVITIES OF FEDERAL AGENCIES, ABSTRACTED FROM PLANNING REPORTS, MARCH 22, 1932

	AGRICULTURE
Departmental	Power plants, quarantine house, shops, administration buildings
Agricultural Eng.	Dwellings, cotton gin laboratory
Animal Industry	Roads, water system, wells, sewers, irrigation, power lines, drainage, animal houses, barns, poultry houses, laboratories, meat-curing facilities, garbage feeding plant, abattoir, meter house, comfort stations, fencing
Biological Survey	Roads, trails, vessels, water development, dams, docks, telephone, hangars, barns, pens, quarters, laboratories, mixing stations, experiment stations, buildings, fences
Chemistry and Soils	Tanks, farm buildings, field laboratories, experiment stations, soil-erosion stations
Dairy Industry	Roads, wells, sewers, drainage, power plant, cottages, barns, laboratories, autopsy building, fences
Entomology	Small cages, greehouses, storage sheds
Experiment Stations	Experiment stations
Food and Drug Admin.	Office building, laboratories
Forest Service	Roads, trails, water supply, telephone lines, landing fields, quarters, barns, laboratories, offices, buildings, fire breaks, fire lookout towers, stock driveways, fences
Plant Industry	Cottages, farm buildings, fences
Plant Quarantine and Control	Houses for fumigating railway cars
Bureau of Public Roads	Roads
Weather Bureau	Buildings
	COMMERCE
Aeronautics	Landing fields, guides for airways, laboratories
Coast and Geodetic	Vessels, observatories
Fisheries	Vessels, docks, laboratories, fish cultural stations, distribution cars
Lighthouses	Roads, vessels, dwellings, office buildings, depots, navigation aids, lighthouses
Mines	Experiment stations, helium reduction plant, garage, car shed, railway cars, fuel yards
Navigation	Vessels
Radio Division	Administration building
Standards	Laboratories, office building
	INTERIOR
Alaska Railroad	Excavation, ballasting, water stations, section houses, structures, bridges
Col. Inst. for Deaf	Power house, dormitories, primary school, library and recitation building, gymnasium
Freedmen's Hospital	Internes' residence
Geological Survey	Gaging stations, plugging oil wells
Howard University	Power plant, chemistry building, classroom building, library
Indian Affairs	Roads, water system, wells, sewers, dams, flood protection, irrigation, power plant, telephone lines, hospitals, schools, dormitories, sanatoriums, gymnasiums, clubs, chapels, auditoriums, jails, quarters, farm buildings, shops, bakeries, office buildings, warehouses, lavatories, laundries, bath houses
National Park Service	Roads, trails, water systems, sewers, electric lines, telephone lines, camp grounds, buildings, fences
Reclamation	Reservoirs, canals, dams, drainage
St. Eliz. Hospital	Power house, receiving building, treatment building, tuberculosis building, dining and kitchen building, farm colony
Virgin Islands	Roads, vessels, water systems, sewers, telephone lines, buildings
	JUSTICE
National Training School for Boys	Roads, power plant, farm buildings, laundry, dining and kitchen building, shops, brick plant, administration building, recreation and chapel building, fire protection
Prisons	Penitentiaries, jails
Prohibition	Warehouses
U. S. Marshals-Alaska	Jails
	LABOR
Immigration	Vessels, dredging, seawall, piers, power plant, hospitals
	NAVY
Aeronautics **Naval reserve** **Construction & repairs** **Marine Corps** **Medicine and surgery** **Naval home** **Navigation** **Ordnance**	Major items of construction are handled by the bureau of yards and docks for these agencies. A certain amount of smaller construction, together with repairs and alterations, are handled directly by the individual agencies
Yards and docks	Roads, railways, marine railways, vessels, water systems, sewers, earthworth, dredging, quay walls, dikes, waterfront improvement, navigation aids, drainage, piers, power houses, electric lines, electric substations, radio stations, hospitals, dispensaries, landing fields, aircraft storage, hangars, barracks, apartment building, quarters, dormitories, guard houses, auditoriums, stables, shops, foundries, laundries, bakeries, torpedo schools, trade schools, schools, administration buildings, ammunition storage, storage, time signal stations, causeways, runways, oil tanks, warehouses, lavatories, garages, moorings, repair basins, cranes, dry docks, fire stations, rifle ranges, bridges, fences

TABLE II CONT.—CONSTRUCTION AND MAINTENANCE BY FEDERAL AGENCIES

	POST OFFICE
Office of Postmaster General	Shops, buildings
	STATE
Foreign Service Administration **Foreign Service Buildings Office**	Embassies, legations, consular offices, residences, apartment houses
Gorgas Memorial	Laboratory
	TREASURY
Coast Guard	Roads, vessels, dredging, seawalls, wharves, hangars, quarters, barracks, academy buildings, life saving stations, shops radio supply building, magazines, launchways, boat houses.
Customs	Inspection stations
Engraving & Printing	
Public Health	Vessels
Supervising Architect	Marine hospitals, post offices, office buildings, immigrant stations, quarantine stations, appraisers stores, departmental buildings, border stations, custom houses
	WAR
Chemical Warfare Service	Narrow and standard gage railroads, pump houses, sewer systems, septic tanks, electric system, heating plant, steam lines, administration buildings, chemical plants, locomotive roundhouse
Corps of Engineers Flood Control	Levees, spillways, bank protection, revetments, dredging
Miscel. Civil Section **Alas. Road Comm.** **Rivers and Harbors**	Dredging, waterworks, miscellaneous civil works, roads, trails, tramways, ferries, bridges, marine railways, vessels, dredging, canals, dams, dykes, jetties, breakwaters, locks, retaining wall, revetments, piers, shops, regulating works, compensating works, bridges
Seacoast Defenses **Militia Bureau**	Roads, water systems, sewers, electric lines, infirmaries, landing fields, bath houses, kitchen and mess halls, corrals, animal shelters, shops, administration buildings, truck sheds, warehouses, drill fields, magazines, rifle ranges, observation towers, tent floors, latrines, gun sheds
Ordnance	Arsenals
Quartermaster Corps	Roads, sidewalks, paved runways, railways, vessels, water systems, reservoirs, sewers, earthwork, seawalls, drainage, piers, power plants, steam lines, telephone lines, hospitals, dispensaries, infirmary, veterinary hospital, landing fields, hangars, barracks, guard houses, gymnasiums, clubs, chapels, schools, academies, recreation halls, farm buildings, stables, pigeon houses, bakeries, shops, incinerators, laundries, photo building, refrigeration, laboratories, post exchanges, theatres, administration buildings, fire houses, warehouses, oil storage, swimming pools, garages, bomb storage, gun sheds, riding halls, signal buildings, hay sheds, wagon sheds, drill hall, coal storage plants, gas works, ice houses, restaurants, target ranges, locomotive houses, machine gun butts, boat houses, picket liens, fences
Signal Corps	Vessels, telephone lines, warehouses
	INDEPENDENT OFFICES
Amer. Battle Monuments Commission	Mausoleums, grave markers, monuments
Arch. of the Capitol	House office, senate office, library of congress, Capitol, Capitol grounds, Supreme Court, power plant, court house, Court of Appeals, Court of Claims
Arlington Mem. Bridge	Bridge approaches
George Rogers Clark Sesqui. Commission	Building and plaza
Inland Waterways Corp.	Vessels, terminal equipment
Boundary Commission, Alaska and Canada	Monuments, clearing line
Boundary Commission, U. S. and Mexico	Gaging stations
Mt. Rushmore Memorial	Monument
Nat'l Advis. Committee for Aeronautics	Power plants, hangars, laboratories, coal storage
Panama Canal	Roads, vessels, water systems, sewers, dams, wharves, locks, piers, drydocks, power plants, hospitals, asylums, dispensaries, quarters, schools, club houses, swimming pools, reformatories, warehouses, shops, incinerators, timber treating, administration buildings, libraries, post offices, police stations, garages, signal stations, locomotive shelters, cemeteries, stadiums, oxygen plants
Panama Railroad	Railways, vessels, berthing space, docks, hotels, laundries, bakeries, office buildings, commissaries, coal storage, coal plants, freight houses, railroad stations, tram shed, bridges
Pub. Bldgs. and Public Parks	Power plant, central garage, federal warehouse, Rock Creek Park, Anacostia Park, recreation centers, The Mall, bathing pools, Meridian Hill Park, bridges, roads, departmental buildings, monuments, memorials
Smithsonian Institution	National Museum, National Gallery of Art, National Zoological Park
U. S. Shipping Board	Army base terminals
Veterans Administration	Hospitals, national homes, barracks, administration buildings

government and the District of Columbia in preparing a schedule year after year of public improvements, together with the estimated cost of these and their allocation to definite years. The charts that are displayed were drawn from reports submitted by the agencies during the latter part of 1931 and represent the first consolidated effort to seek a composite picture of construction for several years ahead. The expenditures indicated represent solely the judgment of the various bureaus reporting. The board has the further purposes of studying and reporting the trend of employment and of business activity and the approach of periods of depression and of encouraging advance planning by all public works and private construction agencies.

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Free-Moving Traffic Capacity With Unbalanced Traffic

DOUBLING the width of a two-lane highway triples its capacity. The addition of one lane to a two-lane road increases its width 50 per cent but raises its capacity 100 per cent. These and the following results are conclusions drawn by A. N. Johnson, dean, college of engineering, University of Maryland, in the May issue of *Public Roads*. They are based on traffic observations made in 1930 and 1931 by two observers in a motor car on roads known to have heavy traffic. During 1930, 51 counts were made at 38 different points between Boston and Washington. In 1931, 33 stations were occupied for a total of 56 counts, mostly in northern New Jersey and Pennsylvania. The survey was a cooperative arrangement between the U. S. Bureau of Public Roads, the State Roads Commission of Maryland and the University of Maryland.

WORKING CAPACITY OF TWO-, THREE- AND FOUR-LANE HIGHWAYS IN VEHICLES PER 5-MIN. INTERVAL

Lanes	Percentage of Traffic in One Direction 50	60	70	80	Average
Two	90	97	90	105	97
Three	185	165	195	175	180
Four	300 est.	300 est.	290	270	290

The capacity noted is working capacity or free-moving capacity, meaning the point at which congestion first becomes apparent. If an attempt is made to put more vehicles than this working capacity over the road, the number passing a given point will decrease.

The evidence is summarized in the accompanying table, showing apparent traffic capacities under different proportions of traffic in opposing directions. The effect of unbalanced traffic on the capacity of two-lane roads is not marked until 80 per cent of the traffic is in one direction, when the capacity rises considerably above the average. On a three-lane road the effect is not so definite, but the maximum capacity is reached when about 70 per cent of the traffic is in one direction. The results for the four-lane road are even less conclusive, as there was no congestion noted when the traffic was 50 or 60 per cent in one direction, although 273 vehicles were counted in one 5-min. interval. The practicable hourly capacities are 1,000, 2,000 and 3,000 vehicles for the two, three and four-lane roads.

Water Line of 60-In. Steel Pipe Pulled Across Mississippi River

By C. C. Wilbur
Principal Assistant Engineer, Minneapolis Water Department

IN IMPROVING the distribution facilities of the Minneapolis water supply a 60-in. submerged steel pipe line was laid across the Mississippi River, being pulled into a trench prepared for it in the river bottom. The lengths were riveted together on shore. No flexible joints were provided. Leakage tests showed that the line is tight. The line is built of lock-bar pipe, $\frac{7}{16}$ in. thick.

The Fridley filter plant at Minneapolis, although located on the east bank, supplies water to the area on the west side of the river only, so that all the water leaving the plant must be conveyed across the river. During the summer of 1931 the peak load during the hours of sprinkling was 96 m.g.d., taxing the capacity of the existing 54-in. discharge main. Because of this condition it was decided to construct an additional discharge pipe, 60 in. in diameter, provision for which had been made in the station at the time of its construction.

At the point of crossing, the river is about 750 ft. wide. The depth of the water varies up to 10 ft., and there is little current. The bottom is blue clay and sand. Sunken logs are common, left from the former days of logging operations, and do not make a desirable foundation for cofferdam work.

The trench for the pipe leading up from the west bank of the river was excavated, and at the top of the bank the trench was widened out and the walls braced, to provide a working pit. All the river pipe was fabricated at this point. The trench across the river was excavated by a dredge to such a depth that the top of the pipe when laid would be at least 2 ft. below the natural bed of the river. Twelve piles were driven on the downstream side of the trench as a safety measure, and several more were driven upstream to facilitate moving the dredge.

A steam hoist was placed on the east bank about 100 ft. south of the point where the line would cross. A heavy block was made fast to the pumping station and also tied to a pile cluster north of the line. On the west bank a torpedo-shaped head was placed in the work pit. To this was riveted the most easterly length of river pipe. Into this length there was placed a double wooden bulkhead filled with sacks of earth. A 1½-in. cable was pulled across the river, fastened at one end to the torpedo head, and the other end was run through the block on the east side of the river. Two triple blocks between this cable and the hoist gave the initial hookup for pulling the pipe.

The first piece of pipe was pulled forward its entire length (30 ft.), the second piece was riveted and calked, and then another pull of one pipe length was made. A repetition of this process constituted the method of installing the pipe in the trench.

The pipe was pulled across the river to the pumping station seen in the background. A trench had been provided for it in the river bottom.

The first six or eight lengths pulled so easily that a holdback line was necessary to keep the pipe from going too far. The pipe in the working pit was 15 ft. higher than the established grade for the pipe in the river. As the work progressed, water was run into the pipe from the west end, which kept it on a much straighter line and gradually lowered the forward end into the bottom of the trench. After the men had become familiar with the work they were able to connect three pipe lengths per eight-hour day. Each joint had 72 1-in. rivets and was calked inside and out.

No great amount of power was necessary to move the pipe where no obstructions were encountered. Dragging the pipe on the clay and sand at a slow rate did not loosen or injure the coating.

When within 40 ft. of completion, the pipe stuck. It was found that the cable clips on the 1½-in. cable had caught on a submerged timber and had lodged against the seven strands of 1-in. cable on the torpedo head to which the main cable was fastened. By applying the power from the hoist, the dredge boat and a truck winch, the pipe was pulled free. After the timber was removed the steam hoist alone pulled the pipe into final position.

When the pipe was completed it was allowed to fill with water and settle into the trench. A small earth cofferdam was built around the dredge boat, and after pumping out, the torpedo head was removed and a steel elbow riveted into place. The line was then given protection and anchorage by depositing around it a section of concrete 6½ ft. square.

Engineering direction

The work was performed under the supervision of N. W. Elsberg, city engineer of Minneapolis, J. A. Jensen, chief engineer of the water department, and C. C. Wilbur, principal assistant chief engineer for the city. The pipe was furnished and installed by the East Jersey Pipe Co., with Dow G. Roof, resident engineer, in charge of conconstruction.

* * *

Tensile Properties of Rail Steels at Elevated Temperatures

It is believed by many that shatter cracks, which are usually found in the heads of rails failing from transverse fissures, are caused by stresses set up while the rail is on the cooling bed, which, in turn, are caused by temperature gradients in the rail sections; also that shatter cracks serve as nuclei from which transverse fissures subsequently develop in service.

Elevated-temperature tensile tests have shown that rail steels are markedly brittle in the neighborhood of 550 deg. C., which is known as the secondary brittle range. It is thought that shatter cracks form in some rails when they cool in the ordinary way through this range of low ductility.

Tests reported in the February number of the Bureau of Standards *Journal of Research* show that slower cooling from the hot saw increases the ductility in the secondary brittle range but decreases it somewhat at about 400 deg. C., so that the ductility curves for the slowly cooled rails fluctuate less than those for normally cooled rails.

There was no difference in the tensile properties of fissured and unfissured rails that had been subjected to the same service. Tests were also made on rails from a mill whose product had a poor service record and on rails from the same mill made subsequently when the product was yielding better service records. Although the ductility of all of these rails did not show a sharp inversion in the secondary brittle range, the values were low at elevated temperatures. Shatter cracks were found in all of the rails that failed in service from transverse fissures, whereas no cracks were found in rails that had been subjected to the same service without failures. Tests on a medium manganese rail deoxidized with zirconium showed this rail also to have marked secondary brittleness.

Floods of Two Types in Middle Rio Grande Valley

Streamflow studies show flood peaks dependent upon geographic position rather than area—Reservoirs have limited possibilities for flood control

By R. G. Hosea
Hydraulic Engineer, Middle Rio Grande Conservancy District, Albuquerque, N. M.

IN ADOPTING the levee system for flood protection of the Rio Grande Valley, above San Marcial, N. M., it was necessary for the Middle Rio Grande Conservancy District to estimate the maximum volume of flow to be provided for and the elevation that such a volume will attain. This project, described in *Engineering News-Record*, June 12, 1930, p. 968, and May 7, 1931, p. 759, includes protection against the floodwater in the river and also, to some extent, against the floodwater in a number of tributary streams or arroyos. As detention reservoirs are not economically feasible, reliance is placed on levees and river regulation.

Drainage Area—Above San Marcial the Rio Grande basin (Fig. 1) lies approximately between longitude 105 and 108 and latitude 33½ to 38½. That portion lying in Colorado, 7,700 square miles, is bounded by mountain ranges that separate it from the basins of the Arkansas and the Colorado rivers and also inclose the San Luis Valley of several thousand square miles at El. 7,500 to 8,000. More than half the Colorado area contributes no water to the river either because of usage or deficient runoff. The principal supply comes from a mountainous area of about 1,400 square miles above Del Norte, at El. 8,000 to 14,000.

South of Colorado the Rio Grande flows through a series of canyons and emerges from the mouth of White Rocks Canyon at Cochiti, the head of the Middle Rio Grande Valley, which extends south 150 miles to San Marcial. In the canyons the river receives several small tributaries draining the west slopes of the Sangre de Cristo mountains, about 25 miles distant. South of Buckman, N. M., there is no important perennial tributary on either side, the only runoff being from floods in water courses that are normally dry.

One large tributary on the west side, above Buckman, is the Rio Chama, draining more than 3,100 square miles, with its headwaters at El. 13,000 in the Conejos range, while its mouth (near Espanola) is at about El. 5,500. South of the Chama are three tributaries from the west, the Jemez, the Puerco and the Salado, which are ordinarily dry but may become raging torrents. In general, the New Mexico portion of the Rio Grande basin is a narrow valley (Fig. 1) protected above Buckman by high ranges on both sides, while below Buckman the basin is wider and protected by lower ranges.

Sources of Runoff—In the mountains of the upper basin the snowfall varies from 100 to more than 400 in. for the year and occurs every month except July and August, with the maximum runoff from snow in May and June. If the snow falls early in the winter, it becomes compact and melts slowly in the spring, causing a low flood peak and a sustained flow; if it falls late, it is looser and melts more rapidly, giving a higher peak flow and a shorter period of runoff. Maximum rainfall, occurring in July and August, is local in character and varies from 2 to 4 in.; its flood menace is negligible.

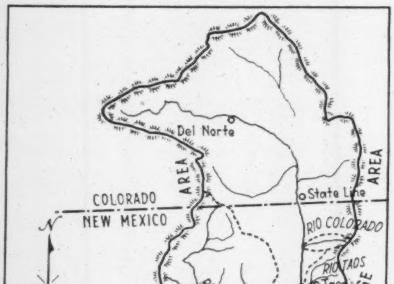


Fig. 1—Drainage area of the Rio Grande, a band about 100 miles wide running north and south in Colorado and New Mexico, is confined within high mountain ranges.

In the arid San Luis Valley the rainfall is 6 to 10 in. and the snowfall 20 to 30 in. The runoff from snow comes much earlier than in the mountain area above. Maximum rainfall, in July and August, varies from 1½ to 3 in. per month, which does not indicate much flood menace.

In New Mexico, above Buckman, climatic conditions are similar to those in the Colorado mountains, except that as the areas are lower and farther south, the snow melts earlier and the spring peak flow passes before that from Colorado arrives. In the Middle Valley, between Buckman and San Marcial, the country changes to the valley type. Rainfall averages 8 in. per year, with a monthly maximum of 1.3 in. in both July and August. Storms of maximum intensity occur apparently at the time of the autumnal equinox and sometimes attain an intensity of 3 in. in three days. Snowfall is very light and produces little or no runoff.

Floods—Thus the floods in the Rio Grande may come from melting snow in the mountains or from summer and fall rain storms. These two causes do not operate simultaneously. Tradition and early history give scanty information about floods. During the Spanish occupation the Indian pueblo of Santo Domingo suffered from several floods in Galisteo Creek. In 1767 a flood in Santa Fe Creek caused loss of life and property damage at Santa Fe. Floods occurred near Albuquerque in 1865, 1874 and the early 80's. The flood of May 21, 1874, is established by the diaries of the Jesuit priests at the church of San Felipe de Neri, in old Albuquerque.

Stream Gaging—Streamflow gaging stations were established at Embudo in 1889, and at Buckman and San Marcial in 1895. The annual spring peak flows (average for 24 hours) are shown in Fig. 2. Five stations have been selected for study of Rio Grande floods from actual records:

1. Del Norte, where the river emerges from the mountains into the San Luis Valley; records are affected to some extent by reservoir storage above, but the station is above nearly all irrigation.

2. Lobatos, near the Colorado state line, at the lower end of the San Luis Valley, is below all reservoirs and irrigation in Colorado.

3. Embudo, at the upper end of the Espanola Valley; there is not much use of the water between the state line and this place, but a number of small tributaries enter.

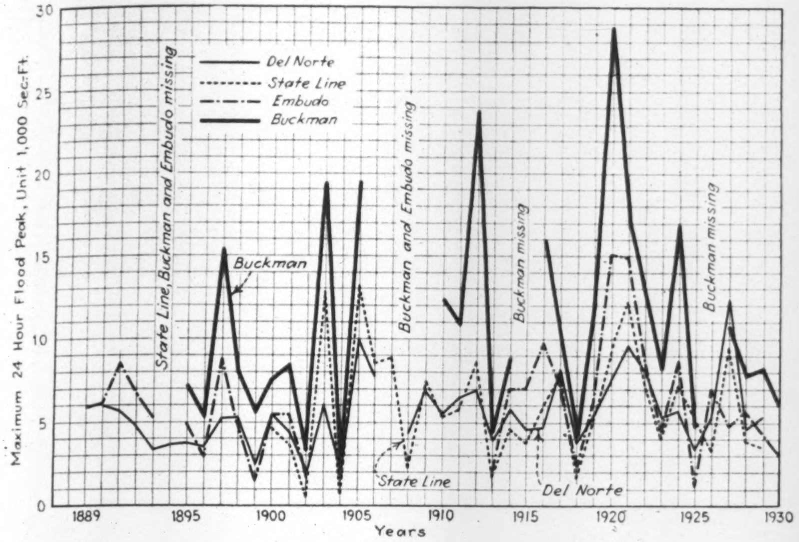


Fig. 2—Maximum 24-hour flood peaks on the Rio Grande from Del Norte to Buckman. High values for Buckman are due to Rio Chama.

4. Buckman, at the lower end of the Espanola Valley, 30 miles from Embudo and near the head of White Rocks Canyon, below which is the Middle Rio Grande Valley; there is a little irrigation in the Espanola Valley, and the Rio Chama enters in this section.

5. San Marcial, at the lower end of the Middle Rio Grande Valley, which has about 45,000 acres of irrigated land; none of the tributary arroyos are perennial, but all are subject to short and violent summer floods.

At Del Norte, Lobatos and Embudo the maximum flow occurs during the spring, usually in May, as a result of melting snow. At Buckman, however, we find eight summer and fall peaks of 6,000 to 18,000 sec.-ft. due to rainstorms; though the fall peaks are the smaller, they show that the river is beginning to be affected by inflow from local storms over tributary areas. At San Marcial some twenty fall flood peaks of 5,000 to 33,000 sec.-ft. are recorded, most of them due to floods in the Puerco and the Salado, which drain 7,500 square miles.

Frequencies of Floods — From the records, duration curves for spring or snow floods were plotted for the five stations, using the coefficients given by H. Alden Foster in "Theoretical Frequency Curves" (*Transactions,* Am.Soc. C.E., 1924, p. 142). The curve for flood peaks at Buckman (Fig. 3) is typical of these duration curves, while Table I is a summary of the frequency data derived from them.

Assuming that the 2 per cent chance flood (or the flood whose probability of recurrence is twice in 100 years) is the volume against which it is feasible to provide protection, the maximum 24-hour flood volume at the head of the Middle Valley is 27,500 sec.-ft. Allowing 2,500 sec.-ft. for small tributaries above Albuquerque would give a maximum of 30,000 sec.-ft. at that place. This figure represents an average flow for 24 hours, but the daily fluctuation would be small at such a distance from the snow fields and probably would not exceed 10 per cent of the average for floods of this type.

Duration curves for summer and fall flood peaks on the Rio Puerco and Rio Grande at San Marcial, with drainage areas of 5,570 and 27,800 square miles, respectively, indicate possible floods, as shown in Table III. The flood hazard below the Rio Puerco is in summer and fall storms of the cloudburst type.

Comparison With Flood of 1929 — After the flood of September, 1929 (*Engineering News-Record,* Aug. 22 and Oct. 7, 1929, pp. 310 and 632), slope-area estimates were made of floodflows in the Rio Grande and some of its tributaries. The peak estimates for the Rio Grande (Table IV) locate the origin of the flood as 8,800 sec.-ft. in the tributaries between Embudo and Buckman, 10,000 between Cochiti and San Felipe, and 3,000 between San Felipe and Bernalillo. These figures, taken from a report by the writer on "Floods in the Rio Grande," in the report of the state engineer of New Mexico, 1928-1930, illustrate the flattening of the flood peak as it traveled down the river. For stations on the tributaries, also given in Table IV, the estimates are thought to be too high, because scour apparently had increased the sectional area as surveyed after the flood.

These floodflows were the result of a three-day storm of unusual severity on Sept. 21 to 23, 1929, over an area centering in the Jemez mountains west of the river and the Sangre de Cristo range east of Santa Fe. The total rainfall at various stations in this area was 3 to 4 in. The relative intensity of this storm is indicated by the duration curve for total September rainfall at Albuquerque (Fig. 4), which shows that

TABLE I — SUMMARY OF FREQUENCY DATA FOR SPRING FLOODS ON THE RIO GRANDE

Station	Drainage Area, Square Miles	Average 24-Hr. Flood Peak, Sec.-Ft.	Coef. of Variation	Coef. of Skew	1 Per Cent Chance Flood, Sec.-Ft.	2 Per Cent Chance Flood, Sec.-Ft.	5 Per Cent Chance Flood, Sec.-Ft.	10 Per Cent Chance Flood, Sec.-Ft.	Length of Record, Years	Years of Record
Del Norte....	1,400	5.500	0.41	1.20	12,500	11,000	9,500	8,500	39	1890-1929 (1907 missing)
State Line....	7,700	5,800	0.61	0.55	14,000	13,000	11,500	10,000	30	1900-1929
Embudo......	9,850	6,300	0.59	1.35	18,000	16,000	13,500	11,000	32	1889-1893 1895-1903 1913-1930
Buckman.....	13,700	10,700	0.61	1.20	31,000	27,500	23,000	19,500	30	1895-1905, 1910-1914 1916-1925, 1927-1930
San Marcial..	27,800	10,200	0.62	1.30	30,000	25,000	22,000	18,000	35	1895-1917 1919-1930

Records do not cover the same time periods and are not strictly comparable.

Above data agree in general with data given for Del Norte, Embudo and San Marcial, in "Flood Flows" by the late Allen Hazen (pp. 66, 67 and 72), which were computed from less recent data.

TABLE II — SUMMARY OF SPRING FLOOD DATA ON STREAMS TRIBUTARY TO THE RIO GRANDE

Station	Drainage Area, Square Miles	Average 24-Hour Flood Peak, Sec.-Ft.	Coef. of Variation	Coef. of Skew	2 Per Cent Chance Flood (Once in 50 Years) Sec.-Ft.	Length of Record, Years	Years of Record
Chama River near Chamita (mouth).	3,150	5,080	0.46	0.14	11,000	18	1913-1930
Red River near Questa (mouth)......	190	441	0.45	0.00	840	15	1913-1925 1927-1928
Rio Hondo near Arroyo Hondo (mouth)......................	73	200	0.47	0.56	420	16	1913-1928
Rio Fernando de Taos near Taos.....	64	81	0.63	1.00	210	16	1913-1928
Rio Taos near Los Córdovas.........	360	390	0.61	1.00	980	19	1910-1925 1927-1929
Santa Fe Creek above reservoir.....	22	79	0.73	0.74	220	17	1913-1929
Rio Puerco near* Rio Puerco station..	5,570	1,347	1.68	4.38	10,000	14	1913-1925 1927

*The duration curve for fall floods in the Rio Puerco indicates a 2 per cent chance flood of 36,000 sec-ft., which may have been equaled during the flood of September, 1929, not included above. This stream and the very similar Rio Salado are the principal sources of destructive floods through the Socorro Valley from San Acacia to San Marcial.

The above data show that there is no particular spring flood menace from east side tributaries such as the Red River, Rio Hondo, Santa Fe Creek and Taos Creek. The principal source of spring flood peaks above Buckman is the Rio Chama. Below Buckman the Rio Jemez (no record available), with a drainage area of 1,000 square miles, probably contributes as much as 1,000 sec.-ft. spring flow at rare intervals, and probably more during occasional fall storms.

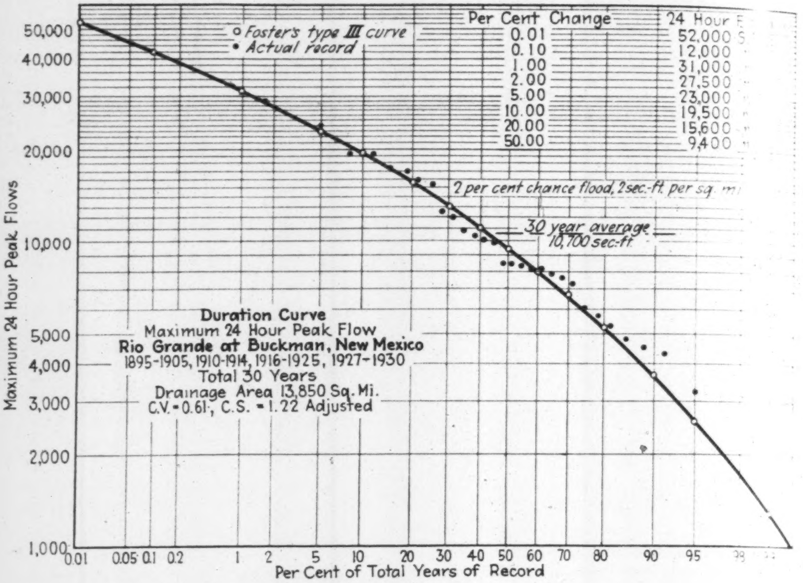


Fig. 3—Duration curve of maximum 24-hour peak flow at Buckman is typical of curves for all five gaging stations.

the average rainfall for the month was 0.8 in. and that the storm was about equal to the 2 per cent chance rainfall for the month, based on a record of 54 years.

It is assumed that the flood peaks resulting from this storm (the worst in 40 years) were fairly representative of high peak flows in the tributaries in the Middle Valley. Automatic gage records give the maximum river flow as 2,200 sec.-ft. at Embudo and 11,000 sec.-ft. at Buckman. With all tributaries between Buckman and Albuquerque peaked at such a time as to produce maximum flow in the river, there should have been 31,000 sec.-ft. at Albuquerque, instead of the 15,000 sec.-ft. obtained from slope-area measurement. The missing 16,000 sec.-ft. represents the difference in time of peak flows reaching the river and the flattening of the flood peak between Buckman and Albuquerque. On this basis the maximum fall flood at Albuquerque is not likely to exceed 30,000 sec.-ft., even with the levees completed north to Santo Domingo.

TABLE III — FLOOD POSSIBILITIES FOR TWO RIVERS

	Rio Puerco, Sec.-Ft.	Rio Grande, Sec.-Ft.
1 per cent chance flood...	48,000	37,000
2 per cent chance flood...	36,000	32,000
5 per cent chance flood...	22,000	25,000
10 per cent chance flood...	14,000	20,000

Flood chances of 1, 2, 5 and 10 floods in 100 years.

TABLE IV — PEAKS OF 1929 FLOOD

	Rio Grande Peaks, Sec.-Ft.	Tributaries		
			Drainage Area, Square Miles	Peaks, Sec.-Ft.
Embudo....	2,200	Santa Fe Creek	326	6,500
Buckman....	11,000	Galisteo Creek	627	5,000
Cochiti......	10,000	Jemez Creek..	1,080	5,000
San Felipe...	20,000	Tonque arroyo	.....	1,450
Bernalillo...	23,000	Tuerto arroyo.	.....	900
Alameda....	16,000	Other arroyos*	.....	1,000
Albuquerque	15,000	Rio Puerco....	6,570	38,000
Isleta.......	13,000	Rio Salado....	1,150	20,000
Los Lunas...	12,000			
Belen.......	10,500			
Mouth of Rio Puerco....	10,000			

*Estimated.

Topography Affecting Floods—Since the usual track of summer storms is from west to east, the protection afforded by the north-south mountains on both sides of the Rio Grande basin is apparent. During the summer the air over the interior of the continent becomes heated and rises, being replaced by cooler air from over the Pacific Ocean. This cool moist air is forced upward by the mountains of California and is condensed, losing a part of its water content. Flowing down on the eastern side, the air is heated and is likely to absorb moisture—hence the aridity of the country between the coast range and the Rocky Mountains.

When these warm-air currents from the west reach the Rocky Mountains, the process is repeated on a smaller scale, precipitation occurring on the west side of the slopes, while the Rio Grand basin is arid. In the same way the mountains on the east side protect the basin from storms originating in the Gulf of Mexico or the Atlantic. The Rio Puerco and Rio Salado, originating in an area not fully protected by mountains, flow approximately eastward or with the storms, a condition that tends to produce an accumulation of water in these valleys. On the east side of the basin the storms travel up the tributary valleys, so that the water from the lower levels runs off in advance of that coming from the higher levels.

Flood Magnitude and Drainage Area—It is apparent that the magnitude of flood peaks in the Rio Grande has little relation to its drainage area. Spring floods at Buckman, with a drainage area of 13,700 square miles, are likely to be larger than at San Marcial, with 27,800 square miles. On the other hand, summer and fall floods, which are rare and of small magnitude at Buckman, may reach 30,000 sec.-ft. at San Marcial and may occur frequently. The more important factors are the amount of protection and the geographical positions of the tributaries.

Summary and conclusions

Experience has shown that floods in the Middle Valley of the Rio Grande are of two distinct types: (1) those due to melting snows in the mountains; and (2) those due to summer and fall storms on tributaries entering the river below Embudo. Flood probability studies indicate that the flood peak at Albuquerque in either case will not exceed 30,000 sec.-ft. for 98 per cent of the time. Below the Rio Puerco the flood peak magnitude decreases due to snow, but that of summer and fall floods increases materially. At San Acacia floods of 50,000 sec.-ft. are not impossible if the Rio Puerco and Rio Salado should flood at the same time. Otherwise, the 2 per cent chance flood is about 36,000 sec.-ft. from the Rio Puerco alone. At San Marcial it is probable that a flood of 32,000 sec.-ft. will not be exceeded for 98 per cent of the time.

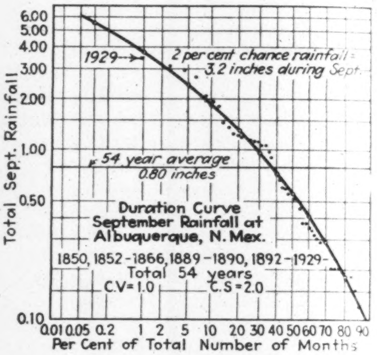


Fig. 4—Duration curve of September rainfall in the Rio Grande Valley at Albuquerque, N. M.

Magnitude of flood peaks is dependent on geographical position rather than drainage area. The position of the Rio Puerco and Rio Salado is favorable to the production of relatively large flood peaks, while that of the main drainage area and the eastern tributaries is unfavorable for such peaks. A flood-detention reservoir, to be effective, would have to be located below Embudo and preferably below Buckman. The proposed reservoir at the state line would have little value for flood protection, though it might have considerable value for other purposes, particularly for storing any drainage return flow that may come into the river above the state line.

Cement-Penetration Road Practice in Australia

Recent experience has developed methods of grouting crushed stone in place, which produce a concrete of high strength and good surface at costs that can be borne by secondary roads

By J. T. Cavanagh
Civil Engineer, Sidney, Australia

THE GROUTED-STONE pavement had a noteworthy place about 25 years ago in American roadbuilding. Its best-known form was the patented Hassam pavement. This was used mostly for street paving. With the handicaps of a royalty charge and irregularity of quality, it was outstripped in the race for high-strength pavement. It mounted too high in cost to compete with other surfacings in the standards set at that time as adequate for secondary roads. The cement-grouted stone road thus virtually disappeared from American roadbuilding. Abroad, however, in the last few years it has come prominently to the front under the name of cement-penetration construction. Notable instances of its use were brought forward at the International Road Congress in 1930 (*ENR*, Oct. 23, 1930, p. 650). A country in which cement penetration has found an economic place is Australia, and in the following article a contributor reviews briefly recent Australian experience. —EDITOR.

CEMENT penetration is playing an important part in building the roads of Australia. Costs have been reduced by as much as five shillings per square yard below those of mixed concrete roads, and results that more than satisfy the demands of secondary-road construction have been obtained. The methods adopted differ somewhat from those in other countries and are indicated best by examples from actual practice.

Recent practice

What may be regarded as normal cement-penetration practice was employed by H. Robinson, shire engineer of Sunshine, Victoria, on a street that carried a considerable amount of mixed heavy traffic and that originally was a 12-ft. macadam road about 3 in. thick on heavy basaltic clay foundations.

The old macadam was very lightly scarified and reshaped, and the clay shoulders were broomed down to meet the grade to a total width of 18 ft., 8-in. curbs being placed along each flank. About 8 in. of 2½-in. new stone was spread in two layers to templet and rolled to a uniform and even thickness of 7 in.

After the first layer of stone had been spread and rolled, the road was divided into 60-ft. lengths, and at each intersection 6-ft. strips of reinforcing fabric were laid transversely across the road 6 in. apart one on each side of the intended joint. The top layer of stone was then spread and rolled, and a 7x1-in. hardwood spacing board, cut to templet and well greased, was inserted into the stone in the space between the two strips of reinforcing fabric. The roller was then run over the joint to level off the displaced stone.

Next the road was penetrated with a 1-cement-2½-sand grout kept in a continuous agitation and poured through a hose. This grouting was done in alternate bays for the full width of the roadway, working from the highest point under construction and from the center of the road to the edges.

After grouting, the surface was rolled longitudinally by a 2-ton power roller, and ½-in. screenings were then spread evenly to a depth of about ¾ in. and rolled in, also with a power roller. The surface was then rolled transversely with a hand roller weighing about 2 cwt. and finished off with a rubber squeegee.

Until recently there has been one objection to the method as described—namely, that the surface was not nearly as good as that of the premixed road. This has now been overcome by the application of a plastic concrete surface. As carried out at Merewether, N.S.W., the grout was not brought completely to the surface, but the top of the stones was exposed to form a key. Immediately after grouting, a concrete of 1 sand, 2 cement and 3 clean $\frac{5}{16}$-in. stone was mixed to a semi-dry consistency and rolled into the interstices of the stones, which had been left exposed. The rolling was accomplished with a 2-ton quick-reversing roller. Extra concrete was added where required, and the whole was screeded to shape and finished with a belt.

The finished thickness of this plastic top was 1 in. The semi-dry consistency of the concrete permitted any excess water that had been used in grouting to be absorbed, and thus the concrete surface was able to be finished in the usual way with a premixed concrete road. Expansion joints, using 2-in. Oregon fir, were provided at 50-ft. intervals during construction. The timber was kept 1 in. below the surface, and the concrete top was finished over the joint. The joint was allowed to take the crack that is normal in a concealed joint and was subsequently painted with bitumen. All corners and edges of the pavement were rounded to ½-in. radius.

Test observations

While some may doubt the strength of cement penetration, considering its low cost, the results of experiments in quite a number of instances show that excellent results can be obtained. The Queensland Main Roads Commission in its work has obtained strengths approaching 3,000 lb. per sq.in. at 28 days, while a corresponding modulus of rupture of 652 lb. per sq.in. has been obtained in the laboratory. A more practical test was applied by W. J. Sunderland, engineer of Sandringham, in which a trench about 8 in. wide by 3 ft. long was made at the side of a cement-penetration road that was slightly undermined. A 6-in. stone cube was placed on the road at the side of the trench, and a 16-ton roller was driven over it. Two impacts were made, with the re-

Applying grout in a cement-penetration road. Note coarse stone and piles of small filler stone applied after grouting.

Placing surface finish of plastic concrete on cement-penetration road. This surface is hand-rolled and finished by belting.

sult that the second impact made a huge crack on the edge of the road. The piece of roadway was then broken off, and it was found that the fracture was a clean one running evenly through the cement and the stone.

In the consideration of the system two questions are invariably asked: (1) Does the grout penetrate completely through the metal? and (2) How do the strengths that are obtained from concrete manufactured by grouting conform to the now generally accepted water-cement-ratio theory of the manufacture of concrete?

Of the many specimens that have been cut for inspection purposes from the increasingly large number of roads being constructed no specimen has yet been cut that has shown an imperfectly grouted road. Thus it can be taken as axiomatic that, given the right consistency—and this is simple of determination with any sand and cement used—penetration is complete.

In answering the second question one must consider primarily the conditions under which ordinary concrete is placed. Under average conditions the full amount of mixing water that is used with concrete is retained within the mass of the concrete, and the strength of the concrete thus obtained will be in direct relationship to the ratio of water to cement, provided the mixture is plastic and workable.

In the construction of a road by grouting system a porous foundation is usually supplied where none exists. Thus it is possible, and actually does happen, that the apparently excess water necessary to obtain the desired consistency that will permit the penetration of the grout becomes absorbed, leaving the water-cement ratio actually in the concrete thus manufactured very much less than that which was originally used in the grout.

Another reason for the high strengths obtained is that, subsequent to grouting operations, the whole mass of stone and grout is vibrated by the action of a 2-ton roller. This vibration of the stone insures that the grout will completely penetrate the voids.

Confirmation of the fact that strength is due to a combination of these conditions may be obtained when a section of the road is cut after completion of the manipulative processes, and a specimen is crushed and compared with the strength obtained from a molded specimen, with the same grout and same metal in a mold that is completely watertight. Many comparative tests made in this fashion show that the strengths obtained on the sections cut from the road are 50 per cent greater.

Two factors appear to be necessary for the success of a cement-penetration job: the prime factor is that the stone to be penetrated should be comparatively coarse; second, the grout should be mixed in such a manner and in such a type of mixer that it will insure a constant uninterrupted flow of the desired consistency, and this consistency should be maintained constantly throughout the operations; thirdly, the consistency of the grout should be such that segregation of the materials cannot take place. It is important that the mixer shall be of such a type that the grout is kept in constant agitation to the period of its entering into the road. Attention to this will assure the impossibility of segregation of sand and cement."

Concrete Piles Tested for Uplift and Bearing

Tests made because of bad foundation conditions of reservoir showed uplift less than settlement for same load

BOTH uplift and bearing tests were made of piles under the new water-supply and purification plant for Fort Wayne, Ind. The site is unusual in that it is municipal dumping ground, but its location near the center of the city, at the junction of St. Mary's and St. Joseph's rivers to form the Maumee, overcame any objections on the score of unfavorable foundation conditions.

Until the time of starting work on the waterworks project a fill of miscellaneous municipal rubbish 20 ft. deep in places had accumulated. It was early determined that the plant should be built upon reinforced-concrete piles. Possible fluctuation of the river level and the dewatering of ground about the tops of piles were considered arguments against wood piles.

The first construction on the site is that of a covered filtered-water reservoir of 20-m.g. capacity, built of reinforced concrete. Columns are spaced 12 ft. apart, and each rests on a group of four cast-in-place piles spaced 30 in. apart. The side walls rest on a single row of piles spaced 4½ and 5 ft. apart. The floor and roof of the reservoir are designed as flat slabs supported by the pile groups and the columns respectively.

Piles were tested for uplift by a beam apparatus connected at the center to reinforcing of the pile under test and were then subjected to pressure from hydraulic jacks at either end.

The pile shells (diameter 8 in. at the point, increasing 0.4 in. for each foot of length) were driven by a single-acting steam hammer with a ram of 2½ tons traveling through a 3-ft. stroke, to a penetration of ¼ in. per blow for the last twelve blows. This indicated a bearing value of 43 tons per pile. The average length of all the 4,600 piles was 16.8 ft.; the soil penetrated was dark yellow clay on fine sand on coarse sand. It was desired to check the bearing power by test, and since there might be uplift pressure on the floor at times of high river stages with reservoir empty, it was desirable also to determine the pile resistance to an upward pull.

For the bearing test a platform balanced on the selected pile was loaded to a total weight of 30 tons, increased after twelve hours or more to 45 tons, and after another twelve hours to 60 tons; this latter load remained for at least 48 hours. Five such bearing tests gave the following results in feet:

30-ton load — immediate settlement, ft.	0.007
After 12 hours or more	0.010
45-ton load — immediate	0.018
After 12 hours or more	0.019
60-ton load — immediate	0.025
After 48 hours or more	0.027
After unloading	0.013

In the uplift tests a jacking pressure of 20 tons was maintained for twelve hours. The jacks bore against a beam connected to the reinforcing bars of the pile under test. The average for five piles was a rise of 0.0024 ft., the maximum being 0.006 ft. and the minimum zero. Thus the average rise was only one-fourth the settlement under equal load.

The Fort Wayne waterworks project is being carried out under the administration of Mayor William J. Hosey and the board of public works (John C. Trier, chairman, David Erwin and Charles A. Ramsay). The plans for the work and supervision of its construction are being carried out by Hoad, Decker, Shoecraft & Drury, consulting engineers, Ann Arbor. The general contractor for the filtered-water reservoir is Buesching-Hagerman & Co., Fort Wayne. The subcontractor for piling is the Raymond Concrete Pile Co., New York.

Boring Machine Digs Wells for Concrete Piers

Cylinder piers for Detroit post office foundations built in wells 118 ft. deep bored in firm clay by special boring machine

By H. A. Christie

Project Manager, The Gow Co., New York, N. Y.

Earth-Boring machines for vertical shafts up to several feet in diameter have had a considerable extension of use in the last few years. They require for their most perfect operation a soil which is reasonably homogeneous and which will stand up to moderate depths for a period long enough to install some form of supporting lining. The clay bed that underlies a large part of Detroit, Mich., is such a soil, which doubtless accounts for the rather remarkable number of uses made in that city of earth-boring machines for tunnels and churn-drilling machines for vertical shafts. The vertical-shaft machine described in this article excavates by a true boring action. Its successful use deserves attention.
—Editor.

A COMBINED boring and excavating bucket was used successfully last spring in sinking through firm clay 106 cylindrical wells for the foundations of the new post office and court house being constructed at Detroit, Mich. The outside wall area of the building is 270x258 ft. It occupies the site of the old post office, which was torn down and the masonry of which was salvaged. An illustration on p. 106 shows the over-all excavation down to foundation level and indicates the arrangement of walls and footings.

The 106 wells ranged in diameter from $4\frac{3}{4}$ to $7\frac{1}{4}$ ft. and averaged 6 ft. Their average depth was 118 ft. Each was dug with a 60-deg. bell at the bottom. The bells were excavated, and the concrete for the bell and shaft was placed by the general contractor; a subcontract was let for boring the shafts to the Gow Co., New York, N. Y., which used a rotary-power caisson excavator of its own special design for the work.

Caisson excavator

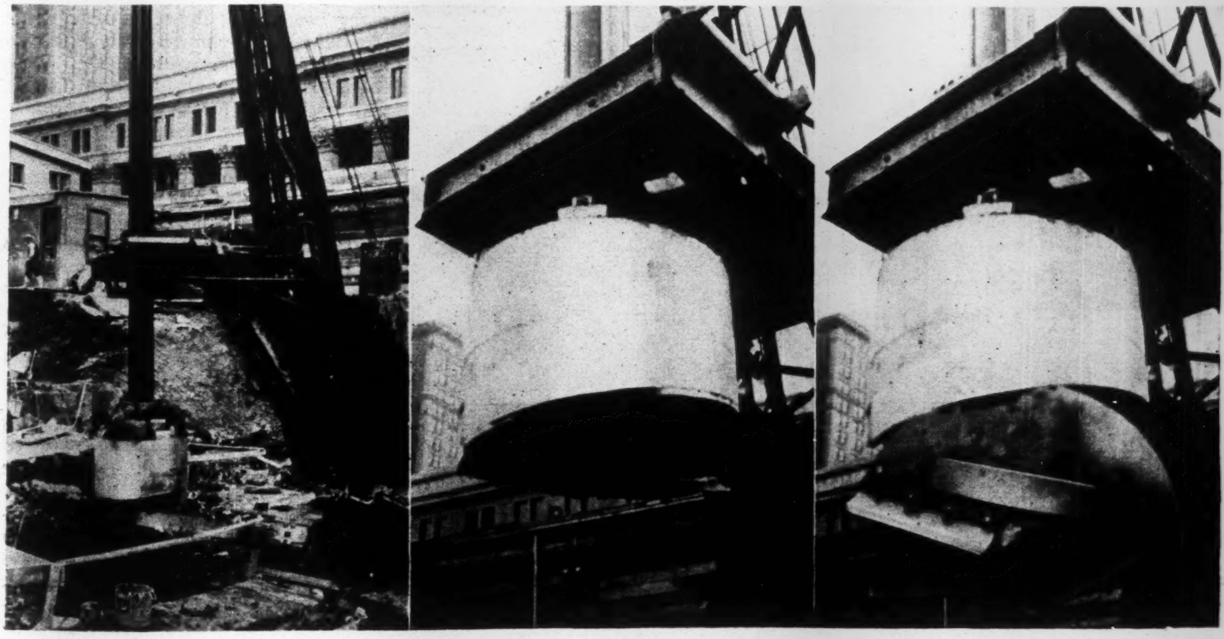
This machine, which is mounted on the turntable frame and crawler tractor of a standard shovel, is electrically operated. The power is generated by a gas engine on the machine or taken from any public source of supply. When electric power is readily available, the gas engine can be replaced by a motor, this motor being fed by weather-proof flexible cable. Power cannot be taken from a city supply direct to the operating motors due to their peculiar characteristics.

The vertical rotating shaft is made up of telescoping sections of hollow machined forgings in 22-ft. lengths and splined inside and outside. The digging bucket is fitted with adjustable-extension reaming knives, which enable the bucket to cut holes of various diameters. By means of these knives it is also possible to undercut lagging in place in the upper part of the hole and maintain the shaft diameter throughout the caisson.

This machine had never been used for holes more than 80 ft. deep, and it was necessary to rebuild it to dig to a depth of 120 ft., the average depth of these caissons being 118 ft. By this means the shaft excavation, amounting to 13,393 cu.yd., was completed in 60 working days. At the start of the work it was thought that probably the machine could dig to a depth of about 40 ft. without lagging in the wells, and that from this point down the lagging would have to be placed in some manner similar to the standard Chicago method. After the first caisson was dug it was found that the holes would stand open all the way to hardpan, and many holes were completed to a depth of 118 ft. with no lagging. The speed with which the holes were excavated was no doubt largely responsible for the fact that they would stand open, as only about ten hours' time was required to dig a well from the average elevation of the basement excavation to hardpan.

It was at first thought necessary to lag the holes when obstructions were encountered, which necessitated a man going into them; but, after about one-half the holes had been completed and no signs of caving or squeeze were noticed, men were confidently lowered inside a steel cage, which would protect them from any small lumps of dirt or sand that might become dislodged from the sides or fall from the top.

In only one hole on the job was a sand seam of any considerable size en-

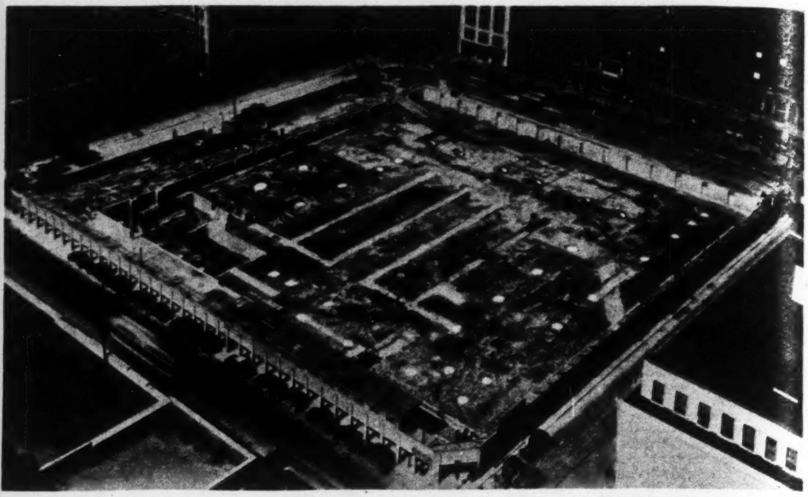


Boring machine carried on frame attached to power shovel and operated by motor geared to vertical shaft, as used on Detroit post office, is shown at the left. In the center view the excavating bucket is closed for boring, while at the right it is opened for dumping, showing cutting edges at bottom and reamer at top.

countered, and this seam was cut off by a steel cylinder, the diameter of which was great enough to allow the wood lagging to pass through it without decreasing the size of the hole. Because the ground would stand open, the contractor was able to build up his lagging in cylinders, using solid lagging rings. These cylinders were 16 ft. in length. When the shaft excavation was completed, the cylinders were dropped down the holes, and if they were a bit tight they were driven to their proper position by a drop hammer resting on a steel frame, with extension arms allowing this frame to rest on any size cylinder employed.

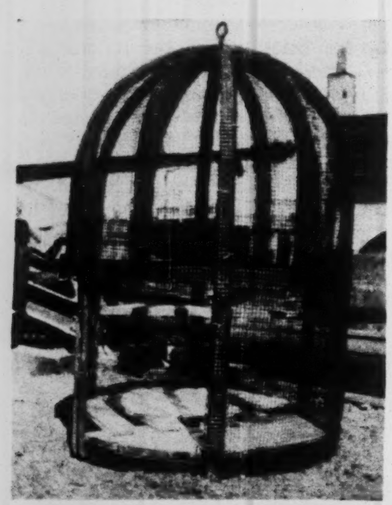
Completing the piers

Because of the rapidity of operation it was never necessary to have more than three or four holes open at one time, and it was found that the complete operation of excavating shafts, lining the hole, undercutting the bell and placing concrete could be completed in four eight-hour shifts. The bells were undercut by hand, using air spades for digging and electric winches for hoisting. The average size bell was completed in 1½ shifts.



Foundations for Detroit post office, with over-all excavation completed and concrete cylinders and cylinder wells indicated.

Safety cage for lowering men to bottom of well and protecting them from falling materials.

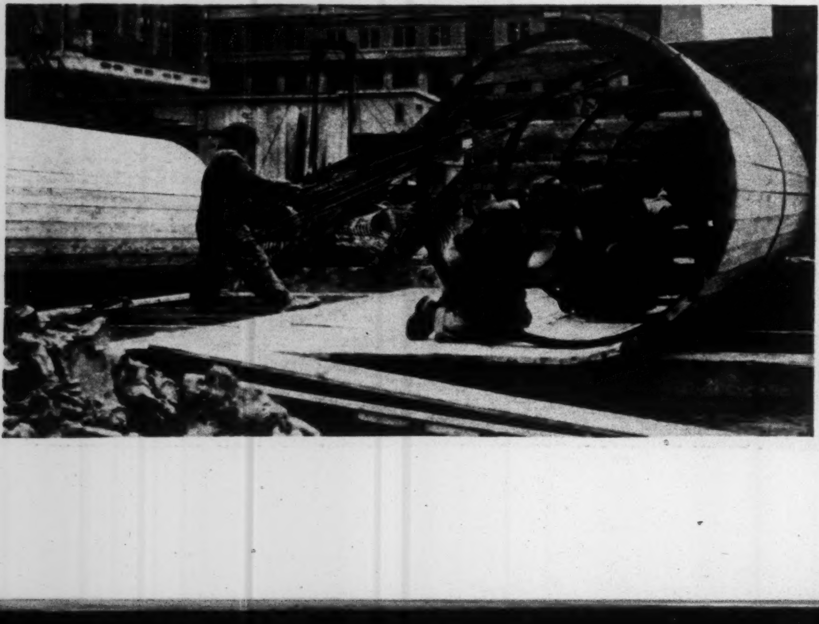


Ready-mixed concrete for the entire job was furnished by a commercial plant in 5-yd. truckloads. All materials were weighed at the plant, and the mixing was done en route and at the site. Practically all the concrete in the job was placed direct from the trucks.

The concrete walls were started before the cylinders were completed, and the last concrete work, together with necessary grading and backfill, was completed 30 days after the digging of the last well. The government allowed 150 calendar days for the completion of the entire work, and final inspection and acceptance were made on April 4, 1932, which was within the original contract time, although the general contractor had received an extension of twenty days because of extra work and unforeseen contingencies.

John Biggs was job superintendent for the Walbridge-Aldinger Co., general contractor, under R. E. Pickett, general superintendent. J. F. Cavanagh was superintendent for the Gow Co., contractors for boring the wells, with the author as project manager in charge. Henry L. Pentz was construction engineer for the supervising architect of the U. S. Treasury Department.

Rolling lagging cylinders for lining the wells preparatory to placing the concrete; cylinders were lowered and driven, section after section, from the top of the well.



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Floating Steamship Landing Allows for 30-Ft. Tide

A landing stage recently put into service for the use of ocean liners in the Thames River at Tilbury, some miles below London, England, provides for a tidal range of 30 ft. The stage, 1,143 ft. long and 80 ft. wide, consists of a series of steel pontoons 80x15 ft. and 7 ft. deep, spaced 3 ft. apart and supporting five lines of box girders. Steel I-beams laid across the girders carry the timber floor or deck. This structure is pin-connected to four steel box-lattice booms pivoted at their shore ends, thus holding the stage in position while allowing for the 30-ft. variation in water level. Mooring cables attached to the shore side of the stage and laid diagonally in both directions to anchorages on shore serve to restrict longitudinal movement to 5 ft. Timber dolphins on the shore side form guides for the vertical movement. Two traveling gantries carry covered gangways to connect the ship's upper deck with a two-story structure from which covered bridges extend to the customs baggage-examining room and the railway station on shore. Baggage is handled on the main deck of the landing stage by electric trucks and low-level bridges. These facilities, built by the Port of London Authority, enable large steamers to land or take on passengers conveniently without the delay involved in going up the narrower and more crowded portion of the river to the London docks.

Large Equipment Units Speed Tunnel Work

River-size diversion tunnel for constructing the great earth dam for the new Swift River water supply for Boston is driven, using truck-mounted twin drill carriages and power-shovel loading of 5-yd. motor trucks

THE MOTOR TRUCK and tractor bulldozer have in the tunneling operation described in the following article very successfully stepped out of their field of open-pit excavation and embankment construction into the ranks of current equipment for tunnel mucking and gang-drilling operations. The power shovel used for mucking is now an old tool of the tunnel builder. Also the motor truck as a gang-drill carriage and for muck haulage, and the bulldozer as a mucking supernumerary had previously established their usefulness in the diversion tunnel work at Hoover Dam. Large tunnel section and rock that does not have to be timbered are the requirements for the most successful use of these large units. A reasonably wide field of tunneling offers these conditions. —EDITOR.

DRILL TRUCKS, power-shovel mucking and motor-truck muck haulage distinguish the construction of a short large-section diversion tunnel now being driven in preparation for building the Swift River dam for the new metropolitan water supply of Boston, Mass. At present the tunnel is the only part of the dam operations under way, and only the excavation is in progress. Later a concrete lining will be placed. An aggregate plant for the concrete is now being installed. The excavation only is described in this article.

Tunnel function

To orient the reader with the purpose of the tunnel, it is noted that Boston is extending its water supply from the present Wachusett reservoir to a planned reservoir on Swift River near Enfield, Mass. A 25-mile tunnel provides the connection. A 14-mile section of this tunnel is now completed to the Ware River near Coldbrook, Mass., and is receiving excess water from this stream by means of a small diversion dam. The construction of this tunnel was described in *Engineering News-Record,* Sept. 11, 1930, p. 420. An 11-mile tunnel under construction continues the line to the Swift River reservoir to an intake far above the dam. The diversion tunnel is no part of the tunnel aqueduct system; its purpose is to divert the river flow during the construction of the dam and later to furnish a way for 4-ft. drawdown conduits and their control gates.

The dam will be an earthfill 175 ft. high and 2,200 ft. long on the crest. The plans for the dam have not been finally determined. It spans between two hills, and the river (which is near the center of the valley) is carried by and under the site of the dam by an open approach channel, a tunnel under the high part of the hill and an open outlet channel. The approach channel is in earth lined with concrete and riprap, and the outlet channel is for a short distance in solid rock. The tunnel is 955 ft. long, with one shaft near the upstream portal, which will house the control works for the drawdown conduits.

Tunnel excavation

The tunnel is mostly of horseshoe section 28 ft. high and 30 ft. wide inside the concrete lining. About 275 ft. of the outlet end, for hydraulic reasons, was enlarged to a section 38½ ft. high and 30 ft. wide, with a semicircular roof arch and vertical side walls. The total excavation is about 45,000 cu.yd. Most of this has been placed in the

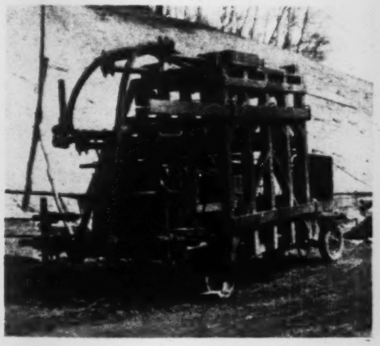

Fig. 1—Drill end of truck, two of which, backed side by side against the face, drill a full round up to 96 holes for either heading or bench cut of 30x25-ft. horseshoe tunnel for Swift River diversion.

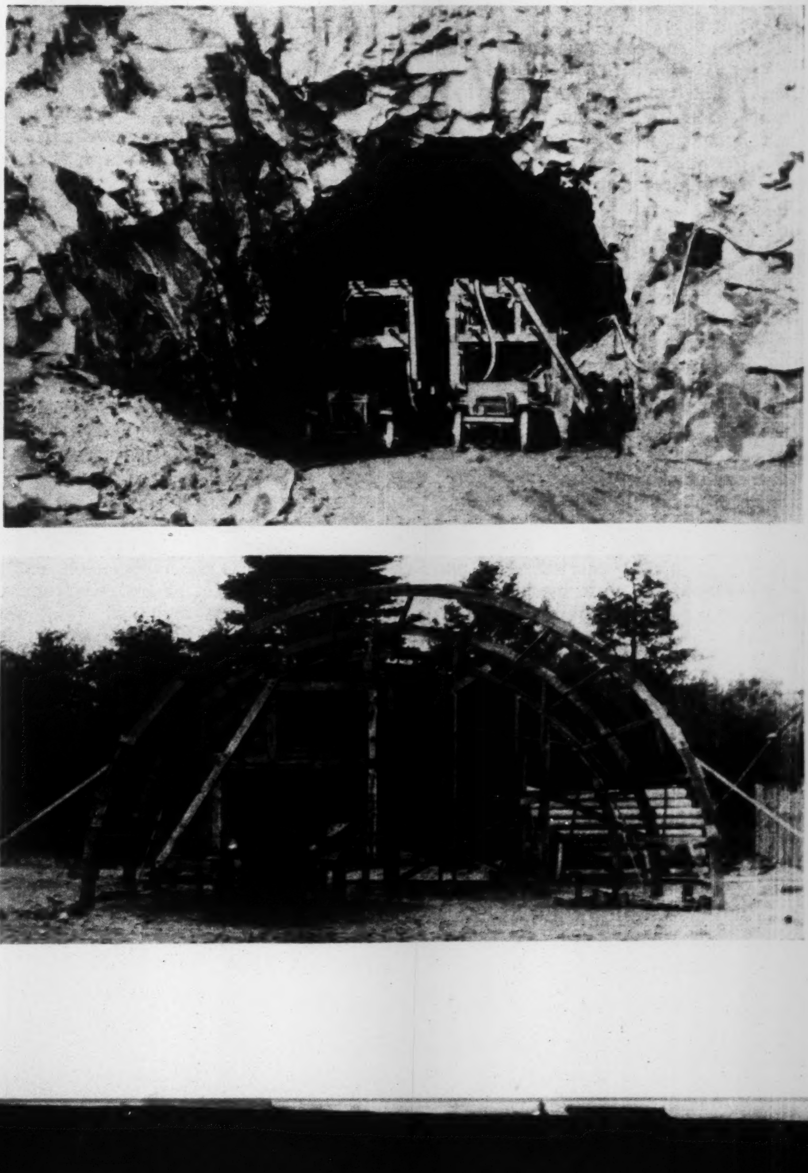

Fig. 2—Twin truck-mounted drill carriages (upper illustration) in working position for drilling bench cut; all holes in bench are horizontal in rows across the tunnel. In the lower view is the templet, giving location of heading holes (by means of small pipe) for checking drill-carriage clearance and coverage of full round of 86 to 96 holes.

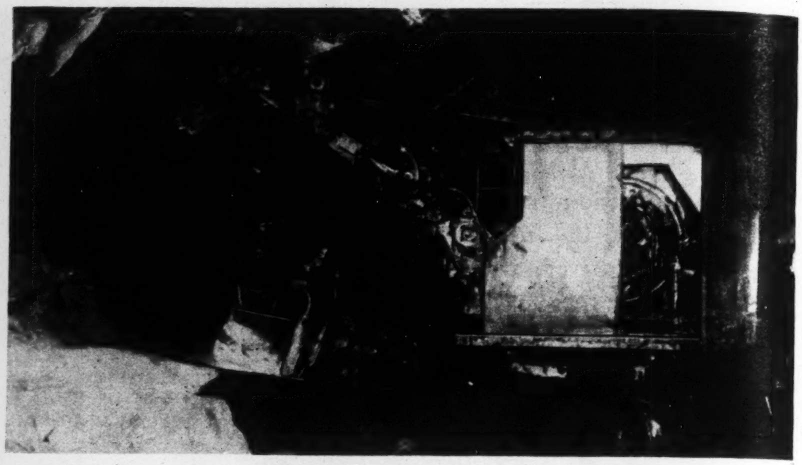

Fig. 3—Electric shovel with 1-yd. dipper working in heading cut; this shovel mucked heading and then bench, loading into 5-yd. motor trucks.

cofferdams, which will shut off the river from the dam site, but part has been stored for concrete aggregate and for future use in the construction of the dam.

The large section of the tunnel and the firmness of the rock, which required no timbering, gave opportunity for large mucking, hauling and gang-drilling units, of which the contractor took advantage. Briefly, two truck-mounted drill carriages drilled first the full-width heading and then the bench, a 1-yd. electric-power shovel did the mucking, and 5-yd. motor trucks hauled the spoil. The other major equipment units were the power plant of three electric-power-driven compressors and a crawler tractor with a bulldozer to gather together the flyrock in the heading.

Two cuts were made in driving the tunnel—a full-width top heading and a bench about 14 ft. deep, except for the last 110 ft. Driving from one end only, the air became so fouled by the muck and truck exhaust gases that a 7x7-ft. top heading was driven through the last 110 ft. to clear the air. This was the only change in the regular procedure, which was to use two drill carriages side by side for the heading and then for the bench, with power-shovel mucking and motor-truck haulage for both.

One of the truck-mounted drill carriages is shown in Fig. 1, and Fig. 2 shows the two carriages side by side in position for drilling the bench; the arrangement was the same for drilling the heading.

To fit in under the curve of the heading roof, the drill-carriage frame was sloped on one side, as shown by Fig. 1. Each carriage had three cross-bars on which five drifter drills were mounted. On the heavy grade the drills were removed when the round was drilled, since their weight on the rear end unbalanced the carriage when it was moving, but ordinarily they remained on the bars. In planning the drill carriages the templet shown in Fig. 2 was constructed. The intrados of this templet corresponded to the neat line of the heading cut. Besides delineating the clearance this device showed the location of the drill holes by means of tamping sticks carried by parallel diaphragms of wire mesh. This arrangement served to instruct the drill runners and to determine whether the drills on the carriage would cover all the holes and whether the long steel would clear. This templet proved highly useful.

The drilling rounds for the heading varied from 86 to 96 holes. All holes were drilled about 18 ft. deep and pulled about 16 ft. of rock. Direct-fired cut holes were used, but the remaining holes had delays of from one to six. All holes were fired in one shot.

In drilling the bench the drill-carriage procedure was as shown by Fig. 2 and substantially the same as in drilling headings. The carriages were backed against the face side by side, and after the round was drilled they were pulled away for blasting and mucking. All bench holes were horizontal and were spaced 3 ft. apart across the tunnel. The top row was 18 in. below the top of the bench, and succeeding rows were spaced 5 ft. vertically. The top row was fired direct, and the other rows were fired in successive delays, except the rim holes, which were fired with the lifters in the last delay.

Both heading and bench were driven from the downstream portal. The roads leading away from the portal were at bench level; in starting the bench, therefore, the cut was carried down to subgrade on an incline. This provided a ramp for the trucks handling the bench muck; this ramp will be taken out with the outlet channel excavation. A 1-yd. electric-power shovel excavated and loaded the muck from both heading and bench. Fig. 3 shows this shovel in the heading. The only other mucking equipment was a tractor bulldozer unit used in the heading to gather up the flyrock and push it up to the shovel for loading. The trucks hauling muck were a regular commercial type with 5-yd. bodies.

Results obtained

The general results of the methods and equipment employed were good progress and a clean open job, except in the one respect of bad air from the truck exhausts, which was soon remedied. The excellent rock (which did not require a stick of timbering and broke neatly to line) helped progress. Another speeding-up device was the templet described, and still another was the use of heated water for the drills in cold weather. This water was pumped from the river through a coil located outside the portal and heated by a wood fire. Freezing air was largely eliminated by this arrangement. The bulldozer should also be mentioned for saving shovel time by collecting scattered rock ready for the dipper.

Perhaps the outstanding effect of the twin drill-carriage method was its effect on drill-crew activity. Each drill crew did its own loading. The drilling shifter or foreman then did the wiring and firing. With its round drilled and loaded, each crew had completed its shift; therefore any less time than the full shift taken by a crew was its own, with pay for a full shift. This encouraged fast work by the crews, which were also spurred on by a self-imposed rivalry in which the crew on each carriage sought to get out of the tunnel ahead of the other. So keen did the rivalry become that the men would not wait for the drill-steel truck to follow the drill carriages into the tunnel but personally carried the starting steel in with them to gain a few minutes in starting the holes. When the steel truck arrived the rival crews were aboard it before it had stopped, each striving for its full share of steel. Both the drill crews and the mucking crews were on call shifts. The drill crews usually worked about six hours, and the mucking crews ten to twelve hours. Incidentally, it may be mentioned that steel canopies over the truck-drivers' seats and miners' hard hats for the men were safety measures adopted.

Engineers and contractors

The tunnel is being built by the Metropolitan Water Supply District of Boston, Frank E. Winsor chief engineer. N. LeRoy Hammond is division engineer in charge of the entire Swift River division. Laroy G. Harris is resident engineer on the diversion work. The contract for the diversion tunnel and for placing the cofferdam embankment is held by Northern States Contracting Co., Leo Butler president, St. Paul, Minn. James F. Horan is superintendent in charge. The firm of B. Perini & Sons, Framingham, Mass., is subcontractor on the outside excavation work.

Visualizing Concrete Economy in Terms of Strength

Straight-line relation between strength and cement-water ratio permits direct measure of cost in terms of strength—Cost per unit of strength decreases with an increase in strength

By Inge Lyse
Research Assistant Professor of Engineering Materials, Fritz Engineering Laboratory, Lehigh University, Bethlehem, Pa.

IN PREVIOUS articles the writer has shown that the strength of concrete is determined by the concentration of cement particles in the cement paste (*ENR*, Nov. 5, 1931, p. 723), and that the design and control of concrete mixes are greatly simplified by this relation (*ENR*, Feb. 18, 1932, p. 248). Data given in these articles show that, for concretes containing aggregates of a given type and gradation, the consistency remains constant regardless of the richness of the mix if the water content per unit of concrete remains constant. Thus the straight-line relationship between the strength and the cement-water ratio of the concrete generates into a straight-line relation between strength and cement content, expressed as follows: $S = A + B\,(c/w) = A + (B/w)\,c = A + Kc$ where S is strength of concrete, A and B are constants depending upon the materials and conditions of test, and c and w are amounts of cement and water in a cubic yard of fresh concrete. If the water content per unit of concrete is held constant, B/w becomes a new constant, K. Thus for given materials and conditions of test the strength of the concrete is proportional to the cement content.

The total cost of the concrete is composed of the cost of the materials plus the cost of formwork, mixing, placing, curing, etc. Since the costs of formwork, mixing and placing are practically the same for concrete mixes of different richness as long as their consistencies are nearly the same, the variation in the cost of concretes of different richness is mainly due to the difference in the cost of the materials—aggregates and cement. For 1 cu.yd. of concrete the cost of the materials may be expressed by: $P = p_1 a + p_2 c$ where p_1 and p_2 are unit prices of aggregates and cement, and a and c are aggregate and cement contents per cubic yard of concrete. Since the total volume of properly placed concrete is the sum of the absolute volumes of aggregates, cement and water, the volume of the freshly placed concrete may be expressed by: $V = V_a + V_c + V_w$. The absolute volumes are obtained by dividing the weight of the materials by their specific weights, so that the above relation becomes:

$$V = \frac{1}{27\times 62.4}\left(\frac{a}{ga}+\frac{c}{gc}+\frac{w}{1.0}\right)$$

$$= \frac{1}{27\times 62.4}\left(\frac{a}{2.65}+\frac{c}{3.10}+\frac{w}{1.0}\right)$$

$$= D + \frac{w}{27\times 62.4}$$

where

$$D = \frac{1}{27\times 62.4}\left(\frac{a}{2.65}+\frac{c}{3.10}\right)$$

$$\text{or } a = 4460D - 0.85c$$

The value 27×62.4 represents the weight of 1 cu.yd. of water, ga and gc are specific gravities of aggregates and cement respectively, and D is density, or portion of solid materials in the concrete.

The cost of the materials is then:

$$P = p_1 a + p_2 c = p_1 4460D - p_1\times 0.85c + p_2 c$$
$$= 4460Dp_1 + (p_2 - 0.85p_1)c$$

Thus the cost of the materials per cubic yard of concrete varies directly with the cement content for given unit prices of aggregate and cement and for a given consistency of concrete.

The cost of the concrete may also be expressed in terms of the strength of the concrete from the following relation:

$$S = A + Kc,\ \text{or } c = \frac{S-A}{K},$$

$$\text{so that } P = 4460D.\ p_1 + (p_2 - 0.85p_1)\left(\frac{S-A}{K}\right)$$

If the strength-giving qualities of the materials are known, it is a simple matter to compute the cost for any given strength of concrete. It follows that for concrete containing aggregates of a given type and gradation and containing a constant amount of water per cubic yard of concrete, the cost per unit of concrete varies with the strength of the concrete.

The following illustration will make the significance of this fact more apparent. Assume the use of aggregates requiring 303 lb. of water per cubic yard of concrete for the desired consistency. The volume of water in the concrete then is $303/(27\times 62.4)$, or 18 per cent of the volume of the fresh concrete. Since the density, D, is the difference between the volume of concrete and the volume of water, $D = 1.0 - 0.18$, or 82 per cent of the volume of the concrete. With these units the cost equation becomes:

$$P = 4460\times 0.82\times p_1 + (p_2 - 0.85p_1)c.$$

If the price of aggregate is \$2 per ton or 10 cents per pound, and the price of cement is \$1.88 per barrel, or 50 cents per pound, the cost of materials for 1 cu.yd. of concrete is:

$$P = 4460\times 0.82\times 0.10$$
$$+ (0.50 - 0.85\times 0.10)c = 3660 + 0.415c$$

cents, where c is given in pounds.

In Fig. 1 the relation between cost and cement content is given for a price of \$2 a ton for aggregates and prices of \$1.10, \$1.88 and \$2.60 per barrel of cement. In Fig. 2 the price of cement was \$1.88 per barrel, and the prices of

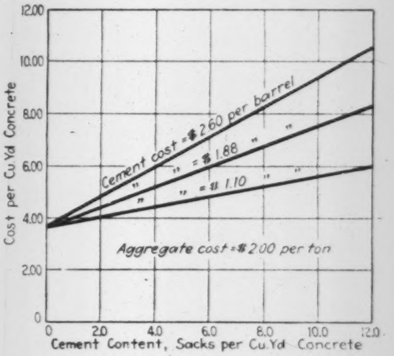

Fig. 1—Relation between cost and cement content of concrete mixes for different prices of cement and with aggregate cost constant.

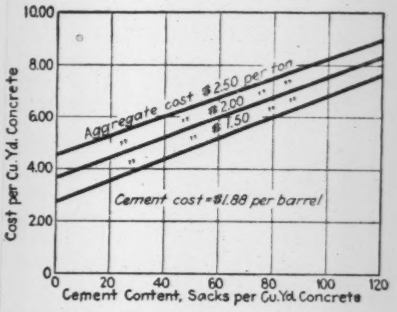

Fig. 2—Relation between cost and cement content of concrete mixes for different prices of aggregate with cement cost constant.

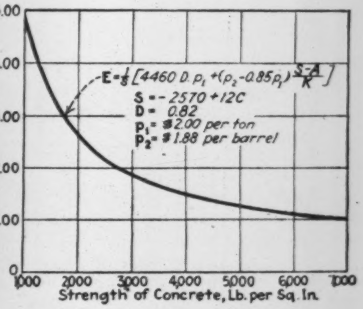

Fig. 3—Cost of concrete per unit of strength (1.000 lb. per sq.in.) decreases rapidly with an increase in concrete strength.

aggregate were \$1.50, \$2.00 and \$2.50 per ton.

In structural concrete members, where the total area is in compression, the load-carrying capacity of the member is directly proportional to the strength of the concrete. The cost of materials for 1 cu.yd. of concrete per pound of strength of the concrete is therefore a direct measure of the economy of the concrete mix. This cost per unit of strength is expressed by the formula:

$$E=\frac{P}{S}=\frac{1}{S}\left[4460Dp_1+(p_2-0.85p_1)\ \frac{S-A}{K}\right]$$

Since for given materials and conditions of construction all units on the right of the equation are given, the cost can be computed directly. The relation between cost of concrete per unit of strength and the strength of the concrete is shown in Fig. 3 for given materials and conditions of construction. It is seen that the cost per unit of strength decreases rapidly with an increase in strength of the concrete. Thus for concrete members loaded directly in compression the more economical mix is the one giving the higher strength.

The above relations are valuable aids for selecting the most economical type of aggregate and cement for use on a given job. The relations also give information as to the feasibility of using ordinary portland or high-early-strength cement. Similar relations may also be found for concrete subjected to flexural stresses. Thus by means of the constant water requirement for a given workability and the straight-line relation between strength and cement-water ratio, the most economical mix is readily determined for all types of plain and reinforced-concrete members.

In addition to the direct effect of the strength of the concrete on the economy of the mix, an additional important economic item is the reduction in size of the member. The benefit of the higher strength concrete is therefore magnified by the accompanied reduction of size of member for a given load. For columns the saving in floor space by the use of high-strength concrete becomes very important.

Long Continuous Girders at Cincinnati Terminal

Weight saved by continuous girders instead of three spans for six-track bridge—Erecting 146-ft. 45-ton girders over busy street

By Truman P. Young
Engineering Department, Cincinnati Union Terminal Co., Cincinnati, Ohio

A CONTINUOUS-GIRDER bridge, with 146-ft. girders extending over three spans, forming part of the south approach to the new union passenger station at Cincinnati, involved special design of long and shallow girders and special arrangements for the shipment and erection of all but two girders as 45-ton units.

This bridge (Figs. 1 and 2), has a central span of 70 ft. across the approach to the West Eighth St. viaduct and two side spans of 26 and 34 ft., giving access to the industrial district crossed by the viaduct. A concrete slab carries six ballasted tracks, and as these tracks had to be connected by cross-overs and double-slip switches on the bridge, a deck design was essential. There are twenty girders, spaced about 5 ft. c. to c., but they are not all parallel, as two of the tracks are on a diverging curve (Fig. 2). These girders are only 50 in. deep, as with the street and railway grades fixed and 14 ft. headroom required, the permissible depth of floor was less than 7 ft. It was proposed originally to have three simple spans on curb-line piers, with a maximum span of about 60 ft. But permission to put piers at the curb lines was refused, and as the increased span would require extremely heavy simple girders, studies were made of continuous-girder construction.

The continuous structure provided several material advantages: (1) a saving of 20 per cent in cost; (2) better appearance, because of the smooth and unbroken lines of the girders; (3) simplification of shoes at the intermediate piers, the width of which was closely limited; and (4) easier erection, because of fewer pieces required and the greater spacing of girders possible. Economy in weight was due chiefly to the extra stiffness obtained. The specifications limited deflection to that of simple girders having a depth of one-twelfth the span, so that with simple spans the unit stresses would have been reduced about 20 per cent, a reduction unnecessary with the continuous girders. In addition, the proportions of the openings were such that with continuous girders the positive and negative moments were nearly equalized. The concrete piers and abutments have concrete-pile foundations.

Structural design

The structure was designed for Cooper's E-65 loading, with impact in accordance with current A.R.E.A. specifications, no reduction being made for the ballast. Copper-bearing steel was specified. The concrete slab, of 2,500-lb. concrete made with $\frac{3}{4}$-in. aggregate, was designed for a live load of 13,000 lb. per foot of track, with 100 per cent impact. Distribution of load on both slab and girders was assumed at 45 deg. from the ends of the ties, and the structure was designed to support a track in any position except on the sidewalks and the wedge-shaped central portion between diverging tracks at the wider end. These portions were raised, as shown, to prevent future placing of

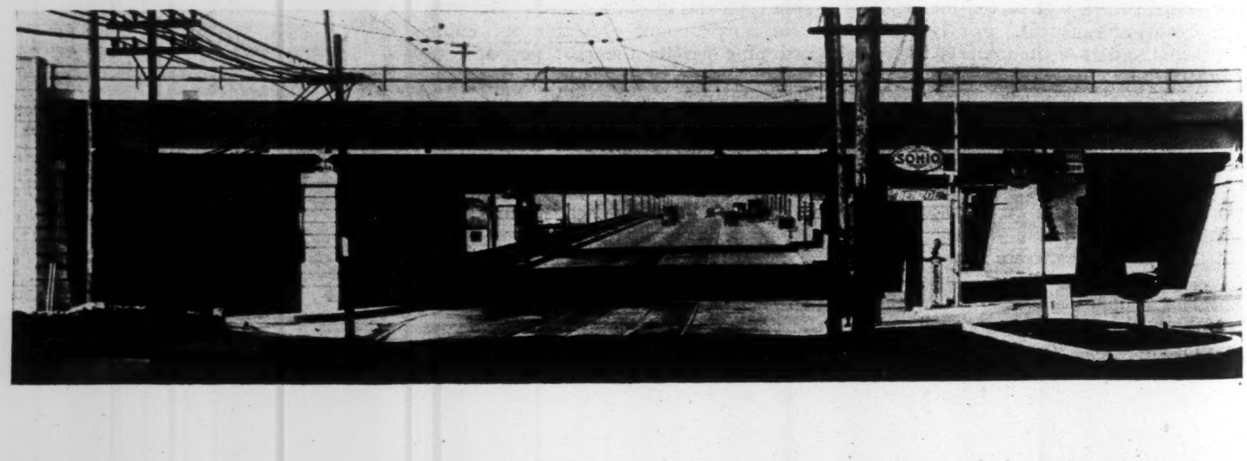

Fig. 1—Girders 146 ft. long are continuous over Eighth St. and two side spans in Cincinnati railway terminal.

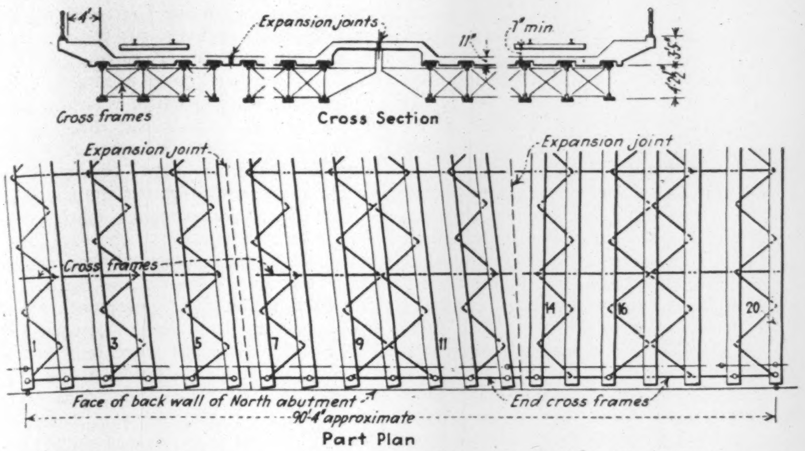

Fig. 2—Six-track bridge has twenty girders and ballasted deck. Deck is designed to permit any disposition of tracks desired except on raised portions.

tracks (Fig. 2). A typical girder is shown in Fig. 3.

As the maximum negative moments at the two intermediate supports and the maximum positive moment at the middle of the central span were found to be equal within 3 per cent, coverplates were made continuous through the central span and dropped off in the side spans, the effect of shortening these plates being taken into account in computing moments. The absence of the usual stack of coverplates materially improved the appearance. Since a bridge had occupied this site for several years, it was felt that settlement of the supports might be neglected, especially as a settlement of ½ in. at the abutment of the shorter approach span would increase the negative moment at the interior support less than 25 per cent.

With the live load occupying the central span, negative reactions are obtained at the abutments. Since any vertical motion or hammering of the girders on their shoes is objectionable, provision was made to resist 1½ times the negative reaction, including impact. The uplift being most severe on the abutment of the shorter side span, the bridge was anchored to this abutment by four 2-in. anchor bolts for each girder. These anchorages were placed with the concrete, pipe sleeves providing the necessary adjustment. To prevent bending of the outstanding legs of the bottom-flange angles, these angles were welded to the end stiffeners.

At the opposite abutment a direct connection through the roller shoes to the masonry was impracticable, and the end cross-frames were designed as a truss to distribute the uplift from any one girder to all others of the same group between expansion joints, where it could be balanced by dead-load reactions. Intermediate cross-frames about 15 ft. apart were similarly designed to distribute the live loads. Lateral bracing was placed between the lower flanges of each pair of girders, but the top flanges were braced only by the cross-frames and deck slab.

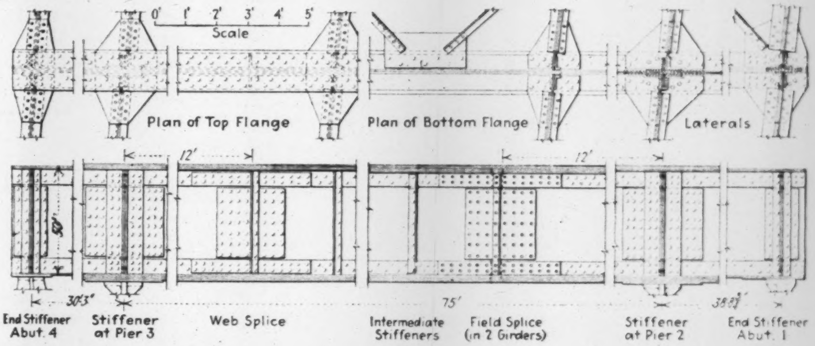

Fig. 3 — Typical girder continuous over three spans. Field splice made at inflection point insured perfect alignment of the ends of the girders without jacking.

All girders were spliced at one inflection point in the central span because of their extreme length. Two of the girders were field-spliced in this way. The splice was made by inserting short lengths of coverplate between the covers on the parts spliced, as shown in Fig. 3. Each splice plate overlapped the cover below, and in addition, 1-in. flats were used on both faces of the flange angles, and web splice plates were used on the web. Flange angles on opposite sides of the web were lapped one row of rivets to facilitate assembly, and the splice so formed had a length of only about 7½ ft. With a splice at the inflection point, no falsework or jacking was required to align the ends before riveting. A splice so located insures perfect alignment of the ends if the supports are level; if they are out of level, the consequent redistribution of moments in the girders will be minimized. Conversely, a variation of the position of the splice is an easy way of effecting a desired redistribution of moment in the girder, although if the splice is located at other than an inflection point, the redistribution is obtained at the expense of a slight kink.

The deck slab was made 7 in. deep to the reinforcement, the bottom being flush with the flange angles and the coverplates being embedded. Forms were wedged against the overhang of the coverplates. To give a good appearance to the structure, the cantilevered side-

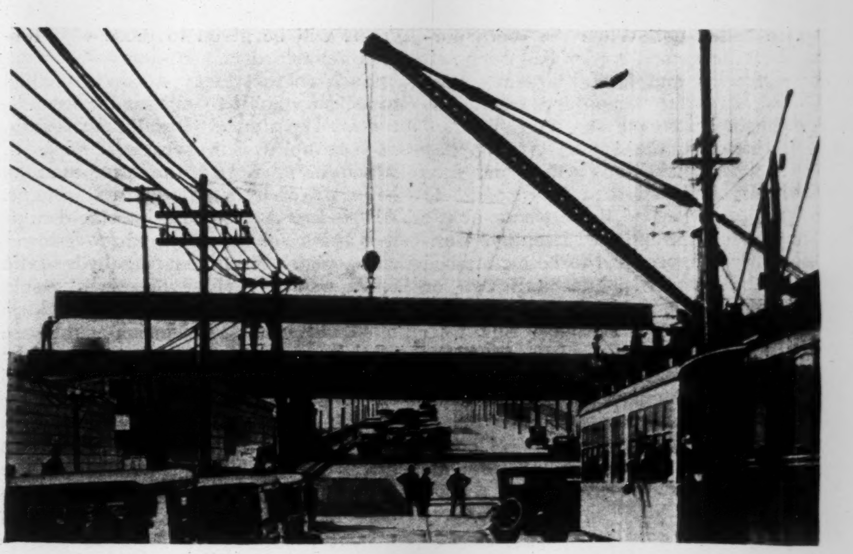

Fig. 4—Derrick car places 96-ft. section of 146-ft. girder. Two center girders were erected in this manner, providing a track support from which derrick car and crane erected rest of girders in a single piece.

walk slab was so shaped as to emphasize the long horizontal lines of the bridge. For drainage the deck is sloped to the north on a grade of 0.7 per cent. The track grade is 0.28 per cent in the same direction, and the difference is taken up in the ballast, with a 7-in. minimum depth under the ties at the south end. Gravel backfill was placed immediately behind the abutment to conduct the drainage to weep holes. On the slab is a two-ply waterproofing membrane, protected from the ballast by 1-in. asphalt plank.

There are two longitudinal expansion joints, each formed by a strip of premolded joint filler. At the joint covered by ballast this filler was placed against a bulkhead, and copper nails were partly driven into it, after which the concrete was poured against it. The opposite side was similarly nailed and secured. This joint is sealed by a 6-in. copper strip, over which building paper and the waterproofing membrane are laid. At the expansion abutment a steel plate embedded in the slab slides on a bronze plate built into the back wall. This joint is waterproofed with copper sealing strips. At the fixed abutment a tar-paper construction joint separates slab and back wall, and the membrane is continued over the joint.

Erection of 146-ft. girders

Erection could be started from the north end only. The two field-spliced girders, mentioned above, constituted a pair near the center of the bridge. The north halves of these, about 50 ft long, extending across the approach span and cantilevering about 12 ft. into the central span, were first erected and braced without the use of falsework. A temporary track was laid on them, and the derrick car picked up the 96-ft. south portion of one of the girders, weighing about 30 tons, by its center and proceeded out over the span just placed, as shown in Fig. 4. With the extreme reach of the boom (about 60 ft.), the girder was set in position and the field splice bolted up. When the south portion of the second girder had been set, cross-frames and lateral bracing were placed, and the temporary track was continued across the structure.

In handling the 146-ft. girders they could not be picked up by the ends, since the flanges would then be stressed to 8,000 lb., or beyond the capacity of the flange when unsupported laterally. Consequently supports had to be maintained near the quarter points until two or more girders could be braced together.

To meet these conditions, skid rails were laid on timber cribbing on the bridge seat of each abutment, the rails being slightly higher than the tops of the shoes. Cribbing was also built up on the piers to support the girders above the level of the skid rails on the abutments. The locomotive crane shifted one 146-ft. girder, shipped on three 50-ft. flat cars, onto the temporary track on the first pair of girders in place. Then the derrick car and crane lifted the girder from its shipping cradles on the cars, swung it laterally and lowered it onto the cribbing on the piers, its ends being unsupported at the abutments. Erection stresses were thus kept within safe limits.

After a second girder had been placed and the cross-frames and lateral bracing bolted up, the pair of girders was jacked down until the ends rested on the skid rails at the abutments. Then they were skidded laterally into position and lowered by jacks onto the shoes. All girders on either side of the temporary track were so erected. Traffic on Eighth St. was interrupted only momentarily, during the heavy lifts, and interruptions were not permitted during rush hours.

Design and construction of the bridge were under the direction of H. M. Waite, chief engineer of the Cincinnati Union Terminal Co., with G. P. Stowitts as engineer of construction, Pusey Jones engineer of design, and L. A. Gillett structural engineer. Design of the superstructure was in charge of the writer, under the direction of J. V. Smythe, assistant engineer. Architectural features were developed by E. D. Tyler, architect for the company. Roger Bear was district engineer in charge of construction. The McClintic-Marshall Corp. fabricated and erected the structural steelwork, and the American Foundation Co., Cincinnati, placed the concrete deck and waterproofing. Piers and abutments were built by the Aug. J. Henkel Construction Co., Cincinnati. Substructure work was begun on April 6, 1931, and was completed Aug. 29. Steel erection was started Oct. 20, 1931, and completed Nov. 10. The deck was started Nov. 18, 1931, and completed Jan. 2, 1932.

Letters to the Editor

Wanted: Data on Dam Uplift

Sir—The committee on dams of the American Society of Civil Engineers is making a study of hydrostatic pressure both within and under the bases of dams. In this connection the committee invites the cooperation of engineers in every country who are designing or constructing dams.

The committee desires facts as noted by careful observation and not opinions or theoretical discussions. Present knowledge regarding actual uplift under and within dams is limited. Therefore we ask engineers when designing a dam to incorporate in their plans methods of observing the hydrostatic pressures that will develop when the structure goes into service. All useful information that comes to the committee will be published for the benefit of the profession, and full credit will be given to those who furnish reliable data.

Each engineer may design a method to measure uplift to suit his local conditions. The simplest installation for observing uplift is a system of pipes in which the pressure at the lower end may be measured by gage or in a riser pipe. All pipes should be built into the dam as it is being constructed, with their lower ends open. For measuring hydrostatic uplift under the base the pipes should terminate in suitably arranged cavities, filled with granular material, at the base of the structure. The pipes should be spaced at intervals along the length of the dam, and at each location there should be not less than three pipes in an up and downstream direction, this number increasing with the width of the base. If a rock foundation has extensive or nearly horizontal stratification, other pipes should be carried down below the base to some of the rock joints. The locations and elevations below the base should be governed by the character of the foundation material, whether rock or soil, and the purpose should be to locate the pipes systematically in both longitudinal and transverse directions, with a view to developing all possible conditions.

For measuring hydrostatic uplift within the structure, similar pipes should be arranged with their open lower ends at different elevations above the base, as the design of the structure will permit. It would be well to have their lower ends open into horizontal construction joints.

The pipes may be led to one or more central observing points as found convenient, so long as the grade is always upward. The size of the pipes is not important but should be such as to permit observations of the water levels within them.

The cost of installing such pipes will be small when a dam is under construction, while the benefits to be derived may be very great. The public has a direct interest in the safety of dams.

We urgently request that the following procedure be carried out:

1. Observe the water level or water pressure in each pipe at intervals that should be practically simultaneous for each cross-section, recording also the levels of the reservoir and tailwater surfaces. The observation intervals should be frequent as the reservoir is filling. Thereafter every week or every month will suffice. At least a year's observations should be recorded.

2. Observe the temperature of the water, both in the reservoir and in the pipes. There is some evidence that uplift pressure may be affected by temperature.

3. Send us the observations at intervals; also drawings of the dam showing the pipe locations and necessary cross-sections, all to scale. The drawings should illustrate the details of the cutoff and the drainage system, if any, and show all other pertinent data. Also describe the character of concrete or masonry and methods employed to secure bonding and to obstruct flow of water through the structure.

4. Send a detailed description of the foundation material, presenting all its known characteristics, together with geological sections, both longitudinal and transverse, showing joint systems, faults, bedding, etc. Photographs of the foundations also will be useful.

5. Repeat the observations asked for in paragraphs 1 and 2 sufficiently often so that seasonal variations will be disclosed. These repeated observations should be sent when made. Do not hold back the data asked for in 1, 2, 3 and 4, as its receipt may suggest the securing of other information that may be highly important.

6. Send all communications to H. de B. Parsons, 26 Beaver St., New York City, U. S. A., who will acknowledge for the committee.

The committee would be glad to correspond regarding details should any one so desire.

COMMITTEE ON DAMS,
AM. SOC. C. E.
Thaddeus Merriman, Chairman
Frederick H. Fowler
D. C. Henny
J. B. Lippincott
H. de B. Parsons
Charles B. Wing
Silas H. Woodard

New York City,
July 18, 1932.

Steel-Faced Dams

Sir—In your issue of May 26, p. 761, there is an article by H. I. Reed illustrating his interesting method for sealing the face of a rock-fill dam with steel plates.

As an advocate of the construction and use of legitimate rock-fill dams, I must protest against the use of steel for this purpose. More than twenty years ago a number of such dams were built in Arizona along the line of the Santa Fe Railway, which invariably became crippled due to the expansion and contraction of the steel with the changes in temperature.

Why experiment with steel when successful dams of the rock-fill type have been built and faced with concrete, such as the Morena rock-fill dam at San Diego, Calif., twenty years ago, 150 ft. high; Dix River dam, Ky., 280 ft. high, completed in 1925; and Salt Springs dam, of the Pacific Gas & Electric Co., completed on the Mokelumne River in California two years ago? The facing of none of those dams has failed, and it should be consistent to adhere to successful materials and practice rather than experiment with novel types. Each of those dams had a concrete rib built into the rock fill, about 3x3 ft. on 60-ft. centers, with a smooth surface projecting about 3 in. beyond the general slope of the rock fill. Concrete slabs were poured in alternate layers against the rock fill, centering on the line of the inserts. This construction limited leaking to the spaces along the joints, and by proper shaping of the joints and proper calking all leakage has been substantially eliminated.

I seriously doubt if the use of steel in Colorado for such purpose would be any more successful than the experience in Arizona, and I would warn all engineers against the futility of copying it.

M. M. O'SHAUGHNESSY,
Consulting Engineer.

San Francisco, Calif.,
May 31, 1932.

Governmental Economy

Sir—The fish and game commission of Massachusetts for 1931 spent $287,000 and took in $279,000 as fees. It has gradually raised the fees from $1 per season to $2.50. It is practically self-supporting, and for 1932 expects to be wholly so.

Many bureaus in Washington are 60 to 75 per cent self-supporting. Is there any reason why they cannot be placed upon the self-supporting list? Water departments are universally self-supporting.

One municipal golf course took in $39,000 for 1931 and spent but $12,000 for maintenance. It is now practically paid for.

I believe the self-supporting idea is spreading, and this year it should be applied more than ever before. It automatically brings out efficiency in operation. A self-supporting government would reduce taxes. Municipal, state and federal departments might one and all be brought to a much more nearly self-supporting basis.

L. F. BUFF,
Buff and Buff Mfg. Co.

Boston, Mass.,
July 13, 1932.

Spread Work Can Bring Relief

Sir—Comment in your letters column has suggested that limitation of employment under the proposed public-works relief plans to 30 hours per week would hardly be "efficient." I do not know what standard of efficiency is implied, but I do know that the efficiency attainable under such a condition would be much higher than that realized by society as a whole today, with large numbers completely idle and supported by local doles. A machine has an over-all efficiency equal to the product of the efficiencies of its component functions or parts, and always less than the lowest of these. The wise engineer will always place major emphasis upon increasing the efficiency of the least efficient part or strive to eliminate it; but idle men cannot be eliminated. And it does not seem reasonable to suppose that work of any kind at all can be more demoralizing than the dole that is spreading so widely in our cities.

Here are a few scattered examples to show how unemployment may be prevented to avoid having to cure it:

A certain branch-office executive employing a dozen men was instructed by his home office to lay off two men. These men, highly trained, would have to be replaced at some expense later on, in time of increased activity. So the branch manager used his head and gave the group the alternative of drawing lots to see who would go on the "dole," or of accepting a *pro rata* cut in time and salary. The group used its collective head and accepted the latter.

A certain sizeable suburban community recently elected a reform administration to effect economy and increase the efficiency of local government. It was seriously and publicly discussed by the commissioners whether it was better to make proportionate cuts down the line or to discharge a certain number, expecting to care for them in idleness by poor relief. It seems hardly conceivable to an engineer that such question could arise; yet the head of the administration is an engineer. Fortunately the sane view prevailed, and all employees were kept at work.

Lastly, the trouble which the board of education of New York City has been having with its engineering personnel is well known. The board wished to use the proportionate-cut method and was commended for its humaneness by the Appellate Court. But the court found that such procedure would be illegal, so out on the street went a number of men.

New York City,
July 11, 1932.

ARNOLD B. STAUBACH.

Relief Funds Usefully Employed

Sir—The following method of obtaining funds for unemployment relief may be of interest to some of your readers.

One of our clients, the water department of a municipality of about 30,000 persons, a number of years ago asked us to investigate the advisability of raising its earth dam about 10 ft. Our recommendation favored this procedure, and we prepared preliminary drawings for accomplishing the change. However, the work was not undertaken at that time.

Recently the water department agreed to contribute to the welfare fund of the city an amount equal to the estimated cost of doing this work by contract. The welfare department agreed to provide unemployed men to do the work by day labor and to make up any insufficiency of funds required to complete the work. In this manner some $50,000 is being contributed to the welfare department, and the city will receive an essential and enduring improvement in return for the expenditure of this money.

Boston, Mass.,
June 14, 1932.

HARRISON P. EDDY, JR.

Engineering News-Record

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Charles Warren Hunt

WITH the passing of Charles Warren Hunt the American Society of Civil Engineers has lost one of those who were most actively identified with the management of the society and the shaping of its policies during the period of its rise to the high standing that it now holds. During the twenty-five years in which he served as executive head of the society—1895 to 1920—the membership of the organization increased from 1,800 to nearly 10,000, the society acquired its own headquarters in New York City (since abandoned for the Engineering Societies Building, but still a financial asset), its finances were put on a sound basis, and an efficient administrative organization was set up. But Dr. Hunt's chief contribution was in the formulation of broad society policies, the setting of high standards for society activities and the constant tightening of membership qualifications as an aid to maintaining the standards set. Twelve years ago when he retired from active work this journal, commenting upon his career, said: "As is usually the case with men of decided convictions, Dr. Hunt has made strong friends and strong enemies. There are those with nothing but praise for his administration, and others who are willing to admit little, if any, good. The truth lies somewhere between." Viewed from the vantage point of the present and with the record of the society's continued progress before us, the conclusion is inescapable that Charles Warren Hunt has left to the society and to his profession a record of unusual accomplishment in their service.

Unworthy Procedure

THE Port of New York Authority has definitely joined forces with those opposing the 57th St. Hudson River bridge at New York. The announcement is not unexpected, but we find it unconvincing and lacking in frankness. The use of the familiar tactics of embracing all known objections to a proposition as one's own, regardless of their merit and without explanatory analysis, is unworthy procedure. We can only assume that the Port Authority's engineering department was not consulted, or if consulted, that its findings were ignored. In reading the recently published letter of the chairman of the Port Authority to the board of estimate of the City of New York one looks in vain for reasons for the statement that the bridge "would prove an actual obstruction to navigation," when it has been shown definitely that the clearance of the structure is ample; also that the bridge would be "a serious menace to the city's new investment in piers for super-liners," when the recent report of the department of city planning presents logical proof to the contrary. The thoroughness of the planning department's report might well have been taken as a model by the Port Authority in its opposing statement. Indeed it is not yet too late to reconsider the matter and, if the spirit of emulation should arise, the Port Authority might profitably confine its objections to the real one—namely, that the bridge constitutes "a conflict with the bi-state program for interstate crossings."

Self-Liquidating Construction

IN STIPULATING that public-works projects must be self-liquidating in order to be eligible for loans under the relief act Congress created new problems of great difficulty for city and state authorities. The act carefully specifies that the loan must be repaid by tolls, fees, rents or charges, or in any event by means *other than taxation*. Cities and states have not generally done their financing and construction on a self-liquidating basis; on the contrary, for many years the trend has been steadily away from toll or excise practices. To turn about now and provide service-charge or benefit-assessment sources of repayment demands highly able and energetic planning and in most cases probably new legislation to segregate and pledge water charges or highway revenues, to impose additional service charges that can be pledged as security for an improvement loan, to operate bridges on a toll basis or to extend special assessment work. Some enterprises, such as the Chicago sanitary district, may be so firmly tied to taxation as to permit of no change, but in general there is enough ability at the command of the local governments, in engineering as well as in law and political administration, to overcome the admittedly great difficulties of meeting the stipulation of the act.

Loans for Construction

UNOFFICIAL information from Washington gives some indication of the attitude in the Reconstruction Finance Corporation toward self-liquidating projects under the new emergency relief and construction act. Most encouraging is the plan to form a central board of engineers and architects to examine all projects as to technical sufficiency and self-liquidating value. Supplemented by regional boards that can advise on local conditions and satisfy the political requirement of geographical coverage, this central board can enlist its personnel on merit alone. Another important proposal involves permission to deposit revenues from self-liquidating public projects in the general tax funds, eliminating the necessity for establishing expensive accounting departments for each project, although it is probable that general revision of bookkeeping practices will be necessary in many cities. There is apparently no disposition to interpret the term self-liquidating in any broader sense than is literally expressed in the act itself. This should not be serious, for present indications are that a sufficient number of eligible self-liquidating projects will be brought forward to command the funds available. Many of these are so near the construction stage as to offer early hope of providing employment. Information on loan maturities, interest rates and procedure are outlined in our news pages, in so far as knowledge of them is available. If unemployment is to be reduced and purchasing power increased before next winter, it behooves all sponsors of self-liquidating projects to acquaint themselves with these pertinent facts and to file their loan applications at the earliest possible moment. Three months from now should see projects under way in every part of the country. Responsibility for initiating them rests squarely on the local community.

Low-Cost Cement Roads

ATTEMPTS to fit portland cement into low-cost road programs have been less ingenious in America than in countries that base their highway practices on European precedent. So far the use of concrete in secondary-road construction in America has been limited largely to reducing the paved width to a single traffic lane with a supplementary lane, or wide shoulder, sometimes of gravel but often of the natural soil. In European practice the full road width has been maintained, and reduced cost has been secured by using a cement-grout-penetrated stone surfacing. The construction procedure adopted displays considerable variation, but in general the Australian cement-penetration roadwork described in this issue is representative. In Australia and widely in Europe this construction is meeting requirements that correspond closely with those of American secondary roads that carry more than ordinary gravel and surface-treated road traffic. On its records abroad grout-penetrated stone-road surfacing warrants further study by American roadbuilders.

Long-Time Planning Progress

THE expenditures for federal construction given in this issue are the first quantitative appraisal of this government activity. The summation represents an important part of the first year's work of the new Federal Employment Stabilization Board. Astonishing totals are reached in its count of the number of agencies that have been active in construction, of the variety of work that they have performed and of the cost of their operations. Yet the figures indicate that the need continues undiminished. The forecasts of the sums that administration agencies consider may be spent productively in the next half-dozen years exceed previous averages.

Primarily the count was made for the advance planning of federal construction, which is the purpose of the law under which the Federal Employment Stabilization Board functions. Secondarily it possesses value as a measure of the federal government as a consumer of construction and as a possible customer for more construction. The suggestion that the figures offer possible economies by centralizing construction operations is plain. But without reorganization the considered presentation of construction needs will require a closer appraisal by every federal bureau of the rank and reasonable value of its work as a part of a general program.

With time, advance planning budgets will crystallize down more closely to essentials than the figures of 1933-1938 planning now indicate is the case. Estimates now being submitted for the second year's report of the board markedly indicate this tendency. Obviously the purpose of the board to perfect the timing of public works with business cycles involves a much greater extension of statistical records to employment, production of basic materials and equipment, wage trends, construction in private fields and several other indices of trade and industry. These activities are naturally developing more slowly, but they have already produced results that hold out promise that federal construction may come to be swung more and more promptly into activity when general business and employment register declines.

The St. Lawrence Waterway Treaty

REALIZATION of the magnificent vision of a waterway for ocean vessels from the Great Lakes to the Atlantic has been given a definite starting point in the treaty for the St. Lawrence waterway and power development. Details aside, the accomplishment as a whole commands praise. With such credit freely acknowledged, the engineer and industrial leader are fully justified if they inquire critically what are the prospects and advantages of St. Lawrence waterway and power development under the treaty. It is obvious that the answer is not simple.

The treaty must be ratified by the United States Congress and by the Canadian Parliament before it becomes effective; domestic differences in both countries must be settled; funds for construction must be provided; and, practically, if not legally, a market must be found for the power before construction can start. Actual construction of a deep waterway therefore still is a long way off.

Some of the obstacles that stand in the way of actual construction are probably minor, such as the difference of view concerning one-stage or two-stage development. Cost distribution, however, is one of the greatest stumbling blocks. The treaty skillfully avoids it, but it will be brought up by opponents of the project.

Other difficult questions that inject themselves into discussion of the treaty are the Chicago water diversion and control over the power developed on this side of the border—whether it rests with the federal or with the state government. Failure to correct the long-standing inequity of water allocation for power at Niagara is still another. All raise fundamental questions concerning the wisdom of the agreement itself, apart from practical difficulties of its subsequent application.

In the matter of power jurisdiction, an inherently difficult question has been rendered more acute by the brusquely non-cooperative attitude of the federal government toward the New York authorities. As a consequence, New York may be expected to block the treaty rather than accept it.

In brief, the treaty has been signed—as a piece of political strategy—but its ratification is far from being assured. Perhaps a treaty less beclouded by political purpose would prove more equitable and in the long run more satisfying. But if the present treaty is ratified, will it bring early construction of the deep-draft ship canal between Lake Ontario and Montreal? Probably not, for the canal is less likely to be constructed as a comprehensive undertaking than as the accompaniment of power development.

Canada already has made provision for inclusion of a channel connecting Lake St. Francis and Lake St. Louis in the intake canal of the Beauharnois power plant and may be expected to do likewise when the Lachine Rapids are more completely developed. In the international section the state of New York and the province of Ontario ultimately will develop the power when the demand becomes great enough. There again the two federal governments will insist that provision be made for navigation channels and locks. Such piecemeal construction may be higher in cost, but that is part of the price to be paid for escaping the national and international problems of a treaty like the present one. The need for the canal as a transportation facility is not sufficiently great to force either government to override the obstacles that now stand in the way of its construction.

NEWS OF THE WEEK

R.F.C. Loans to Be Supervised By Engineer Control Board

Unofficial information also reveals probable interest rates and tentative procedure for applying for loans for self-liquidating projects

Special Washington Correspondence

SLOW progress made by the Reconstruction Finance Corporation in setting up its organization and procedure for granting construction loans under the Emergency Relief and Construction Act is attributed to the pressure of business under the old act and to the delay by President Hoover in finally approving the bill and appointing to the board of directors successors to Eugene Meyer, governor of the Federal Reserve Board and Paul Bestor, chairman of the Federal Farm Loan Bureau.

Numerous questions with reference to Title II of the new law, which embraces loans to states, municipalities, and private corporations for self-liquidating construction projects cannot be answered until the corporation drafts appropriate regulations for its administration. On several important points, however, the corporation's policy has been revealed unofficially.

Probable Interest Rates

The interest rates on construction loans will vary between 4 and 6 per cent depending on the borrowing agency and the type of project. In general, a higher rate of interest will be exacted from private corporations eligible for loans than from states and municipalities. As the R.F.C. has been able to obtain its funds to date at an average of 2 per cent, it is anticipated that rates charged to states and municipalities will not exceed those required to market their securities in normal times. Where bidding is required under state or muncipal law, the R.F.C. will retire if it meets competition from private capital that is willing to take a lower interest rate. It is hoped, of course, that the entry of the R.F.C. as a source of credit will attract competition from banks and other lending institutions. Due to the precarious financial condition of many carriers, this did not follow when R.F.C. funds were made available to railroads early in the year.

Accounting for Revenues

Revenues from "self-liquidating" projects engaged in by states and municipalities may be deposited with general tax funds but must be pledged to payment of interest and principal of the loan. Whether authorization by law or ordinance will be necessary for this purpose will depend on existing legal provisions governing the procedure of the state or municipality concerned.

Supervisory Board of Engineers

A central project board, composed of salaried engineers and architects, will be formed by the R.F.C. to examine the plans for all projects and to estimate their self-liquidating character. The central board will set up regional advisory boards in the

(Continued on page 119)

Bid Accepted for Construction Power for Los Angeles Aqueduct

Electric energy required in construction of the Colorado River aqueduct of the Metropolitan Water District of Southern California will be supplied jointly by the Southern California Edison Company, Ltd., the Los Angeles Gas and Electric Corp. and the Southern Sierras Power Co. Directors of the water district on July 15 voted to accept a power supply bid submitted by the three companies.

The power supply provided for in the bid is to be used only in aqueduct construction camps and for the operation of construction equipment during the five or six years that building work will be in progress. All electric power to be used in the operation of the aqueduct is to be obtained from the Boulder Canyon project. The contract with the power companies will not become operative until the district board gives written notice that the power supply is desired.

It is provided that the district shall pay an energy charge of five mills per kilowatt hour for all energy used, a fixed monthly payment of $1,500 and a minimum monthly charge of $3,000, this latter minimum to include the $1,500 fixed charge.

◆

Golden Gate Bridge Approved By Federal Court

Upholding the legality of the proposed bond issue for the Golden Gate bridge, the decision rendered by the lower federal court affirms the findings of the California Supreme Court and finds that the project does not invade any constitutional rights. Attorneys for the interests opposing the project have announced that steps will be taken to carry the case to the United State Supreme Court. The $35,000,000 project has been halted for months by these legal proceedings although the bond issue for the 4,200-ft. suspension bridge was voted by the district November, 1930. Civic interests are prevailing on the opposition to consider the last court decision as final and to drop further action. One of the major groups admittedly backing the litigation is the ferry company operating across the Golden Gate.

◆

Distribution of Federal Loan for Roadbuilding

Of the $136,000,000 provided for roadbuilding in the relief bill signed by President Hoover on July 21, all but $16,000,000 designated for use in federal lands, reservations and parks, will constitute a loan to the 48 states and the island of Hawaii. The distribution of this loan follows the provisions in the act governing regular federal aid:

Alabama.	$2,550,053	N. H. ...	$600,000
Arizona...	1,762,636	NewJersey	1,659,121
Arkansas.	2,091,431	N. M. ...	1,962,340
California.	4,669,711	New York	6,057,965
Colorado..	2,255,281	N. C. ...	2,890,203
Conn.....	779,324	N. D. ...	1,940,325
Delaware.	600,000	Ohio	4,501,069
Florida...	1,629,204	Oklahoma	2,893,101
Georgia..	3,120,191	Oregon...	1,996,128
Idaho....	1,508,485	Pa......	5,261,052
Illinois...	5,077,245	R. I.....	600,000
Indiana...	3,060,266	S. C......	1,666,492
Iowa.....	3,173,493	S. D.....	2,002,076
Kansas...	3,276,334	Tennessee.	2,609,757
Kentucky.	2,259,648	Texas....	7,668,024
Louisiana.	1,740,196	Utah....	1,387,190
Maine....	1,070,600	Vermont.	600,000
Maryland.	1,015,296	Virginia..	2,258,196
Mass.....	1,712,774	Wash....	1,905,627
Michigan.	3,783,179	W. Va....	1,316,720
Minnesota	3,373,560	Wis......	2,992,438
Miss.....	2,160,628	Wyoming.	1,540,811
Missouri..	3,761,014	Hawaii...	600,000
Montana..	2,525,108		
Nebraska.	2,557,683		
Nevada...	1,578,025	Total..	$120,000,000

◆

Court Dismisses Taxpayers' Suit to Cancel Paving Contracts

The suit to cancel six state highway paving contracts in Minnesota, referred to in *Engineering News-Record,* May 19, p. 742, and May 26, 1932, p. 775, has been dismissed. The suit was brought by taxpayers, who claimed that excess profits were being made on state highway work through the application of the pre-qualification clause in the contracts.

The taxpayers' action was dismissed on the ground that they had no standing in court. However, the suit in intervention that has been filed by the attorney general, which reiterates all the allegations filed by the taxpayers' suit, will stand. The contractors have been given 20 days in which to file answers.

◆

Los Angeles Engineering Bureau Going Through Reorganization

The reduction of $1,250,000 in the Los Angeles, Calif., bureau of engineering budget, under the general budget reduction for the city during the present fiscal year, has entailed the reorganization of the entire bureau. Under the reorganization, J. J. Jessup will continue as city engineer. The post of chief deputy, formerly held by R. W. Stewart has been abolished and Mr. Stewart has been appointed engineer of bridges and structures. Approximately thirteen division heads, who formerly reported directly to the city engineer, are grouped as assistants to three deputy engineers. These deputy engineers are H. P. Cortelyou, former engineer of construction; D. M. True, office engineer, and Merrill Butler, former engineer of bridges and structures. Mr. Cortelyou will be in charge of street, sewer, storm drain, surveys and structural design. Mr. True will be in charge of administration, accounting, personnel division and general offices, and Mr. Butler will supervise all maintenance, operation and disposal.

Approximately 250 engineers of the department are now on half time, while most of the remainder of the employes have had salary reductions ranging from 10 to 11.5 per cent.

◆

New Water Rates in Cleveland Yield Increased Revenue

The water division of the city of Cleveland made a net profit of $435,000 in the year ended June 30, a statement prepared by utilities director A. R. Brueggeman shows. The statement was prepared as a memorandum to show the division's financial condition, preliminary to issuance of a $4,000,000 bond issue authorized by city council for expansion of the division's facilities.

The director declared that new rates and more efficient operations would justify an issue as high as $10,000,000. Although the profit was shown during the year just ended, the preceding year ended with a slight loss and two years ago the division was unable to meet bond retirements and interest.

◆

Federal Court in Indianapolis Upholds Lowered Water Rates

The action of the Indiana Public Service Commission in setting an emergency schedule of water rates for Indianapolis was upheld by the federal court in its denial of a petition by the Indianapolis Water Co. for an injunction against the rates. The emergency schedule set by the public service commission reduced the minimum monthly charge from $1.50 to $1.08 and cut $65,000 from the city hydrant rentals. The history of the case leading up to the action of the commission was reported in *ENR* June 30, 1932, p. 930.

A rate-base valuation of $21,250,000 was upheld by the court, substantially the figure set by the commission. The water company sought a rate base of $26,456,000. The court held that a return of 6 per cent on the approved valuation was not confiscatory.

◆

Louisiana Negotiates Loan to Complete Highway Contracts

Negotiations have been completed for loans to the Louisiana state highway commission totaling $1,200,000, to be used for completing existing road contracts. The loans are part of the $2,500,000 authorized by the last session of the state legislature, as reported in *ENR*, July 14, 1932, p. 59. The money is not to be available for any new contracts, being limited in its use to the completion of those now under way.

Loan funds will be made available by the lending banks at the rate of $200,000 per month and will bear 6 per cent interest.

Cities and States Apply Promptly for Relief Bill Aid

STATES and municipalities have already begun to move to utilize the federal credit made available by the new emergency relief and construction act.

Application has been made by the village of Wilmette, Ill., to the R.F.C. for $600,000 with which to construct a 6 m.g.d. waterworks consisting of filtration plant, pumping station and intake. Water revenue bonds, serviced only by moneys collected from consumers are offered to the R.F.C. and are considered by the village officials as fitting the self-liquidating clause in the relief act. Many unsuccessful efforts have been made to sell the bonds for enough to build the plant. Bids were taken Apr. 5 but were subsequently rejected because the bonds could not be marketed. The state law under which the bonds are issued requires that the rates charged shall be sufficient at all times to pay the principal and interest, the expenses of operating and maintaining the entire system and the establishment of a depreciation fund, all to be set aside in a special fund.

Lake cities seek aid

The city of Toledo, Ohio, will attempt to secure a $15,000,000 loan from the Reconstruction Finance Corporation providing it can establish the merit of the construction it proposes. Mayor A. Q. Thacher heads the move to secure the funds. A large part of the amount will be required for the construction of the proposed Lake Erie water supply system for the city, a project which has been long delayed. Early plans called for an expenditure of about $15,000,000 but revised plans incorporating a shorter intake tunnel will require only $10,000,000. Another million dollars is for building a winter mooring station for lake freighters and a modern freight cargo terminal. Reclamation of from 1,000 to 1,500 acres on the East Bay shore would require from $4,000,000 to $5,000,000. The water system would be financed by water revenues, the lake freight accommodations would pay for themselves through leases and fees and the reclamation project would furnish a return on sale of bay frontage, according to the city authorities.

Money for new bridges

Both the San Francisco-Oakland and the Golden Gate bridge projects have applied to the R.F.C. for financial support. The former, a state project to be financed by revenue bonds, will involve a total estimated cost of $75,000,000. C. H. Purcell, California state highway engineer and chief engineer for the project, is now in Washington in the interests of a loan. The Golden Gate project, although at present involved in litigation, has made application through the local Federal Reserve Bank and also directly to the corporation.

Wellsville, N. Y., will install a complete new sewer system at an estimated cost of $178,000 providing bonds can be disposed of at 2½ per cent interest or less. The village board will attempt to take advantage of the new federal aid law to obtain money for this improvement.

Mississippi will utilize federal credit to aid it to launch a $4,000,000 road construction program within the next month, according to an announcement by E. D. Kenna, state highway director.

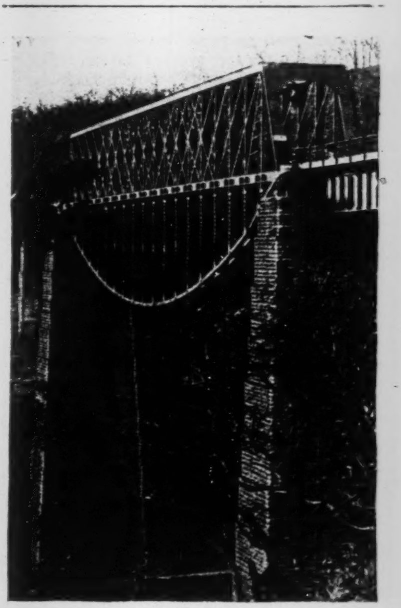
Mississippi's share of the extra $120,000,000 provided for highway loans is $2,000,000. With this money the state can obtain an additional $2,000,000 from the regular federal aid fund. The state highway commissioners have tried to match the federal aid money heretofore with the proceeds from a $5,000,000 highway bond issue, but the bonds have never been marketed.

Governor Laffoon, of Kentucky, has applied to the R.F.C. for a loan to his state of $15,000,000 to be used in furnishing work relief and in relieving unemployment. The governor in telegraphing his application explained that the resources of his state, including all money now available, are inadequate to meet its relief needs.

The governor of Illinois has also applied for funds to be used in furnishing relief and work for the people of his state. His communication to the R.F.C. states that there are now 1,150,000 workers unemployed in Illinois and that 160,000 families are being furnished subsistence at a cost averaging $20 per family per month, aggregating $3,355,000 monthly. Local funds available for relief purposes, including the $10,500,000 raised by private subscription in November, 1931, and $17,950,000 of state money supplied by the sale of bonds, will be entirely exhausted by Aug. 1. The resources of the state, its political subdivisions and private charities are termed inadequate to meet the relief need.

Governor Pinchot, of Pennsylvania, has applied to the corporation for $45,000,000, the maximum any state is allowed.

The secretary of the R.F.C., George R. Cooksey, has sent a telegram to each of the 48 state governors asking that they co-operate with the corporation during the time necessary for the formulation of administrative policies.



STRENGTHENED TRUSS BRIDGE

This 250-ft. through-truss Dhorabhavi bridge on the Madras & Southern Mahratta Railway, India, has been strengthened by an underhung bowstring. There are no diagonal members, only the vertical struts seated between the bowstring chords and the bottom chords of the truss span.

Municipal Power and Water Plant for Denver Suburb

Englewood, Colo., Denver's southern suburb, by a vote of its town council on July 11, is preparing to carry out its plan for a municipal power and water plant. The low bid recently received for the construction of the project was $599,872 by the Municipal Power Development Co., of Minneapolis, Minn.

The water supply proposed will consist of four wells and a 600,000-gal. reservoir. The electric plant will comprise three oil engines with a capacity of 500 kw. each. At present Englewood buys its water from the Denver water department and its power from the Colorado Central Power Co.

The program to finance the undertaking involves issuance of bonds to the contractor. Bonds are to be paid out of earnings of the water power plant and will not be a mortgage against the municipality. A special election in which property owners are expected to validate the transaction will take place soon.

◆

Power Dam Proposed on Mississippi at St. Louis

Notice has been filed with the officials of St. Charles and St. Louis counties, Missouri, and Jersey and Madison counties, Illinois, that an application has been made by the John H. Gundlach Real Estate Co. to the Federal Power Commission for a preliminary permit for the construction of a large power dam on the Mississippi River near the Chain of Rocks Bridge, St. Louis, Mo.

The notice states that the power project will develop 175,000 hp. to be used to serve industries near the site of the dam. There will be constructed a system of navigation locks near the Missouri shore and an earth embankment to connect with the existing levee system on the Illinois shore, where the power house is to be located. The proposed dam is to raise the low water stage of the river above the dam to 25 ft. and will back water as far upstream as Grafton, Ill., near the mouth of the Illinois River. The counties, the city and individuals have until Sept. 15 to file objections to the application.

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Sir Henry Thornton Resigns as Head of Canadian National

Sir Henry Thornton, president of the Canadian National Railways since 1922, resigned his position on July 19. Until his successor is appointed, S. J. Hungerford, vice-president in charge of operations and construction, will be acting president.

In the report of the last session of the parliamentary committee on National Railway expenditures many projects were criticized as extravagant and unwarranted. In his letter to the Minister of Railways and Canals in resigning his position, the president referred to this criticism and explained his resignation as a move to give the government a free hand in their consideration of expenditure policies. A royal commission is inquiring into the railway situation and will report in August or September.

Sir Henry Thornton was an American engineer who was with the Pennsylvania Railroad until 1914. In that year he went to England to become general manager of the Great Eastern Railway. In 1922 he was appointed president of the Canadian National Railways by the Canadian prime minister.

◆

Charles Warren Hunt, Secretary Emeritus of Am.Soc.C.E., Dies

Charles Warren Hunt, secretary of the American Society of Civil Engineers from 1895 to 1920 and secretary emeritus since the latter date, died at the Engineers Club in New York on July 23 following a brief illness. Dr. Hunt had been in ill health much of the time since his retirement from active life but had been a familiar figure in the Engineering Societies building and at the Engineers Club.

Charles Warrent Hunt, from a photograph taken while he was secretary of the American Society of Civil Engineers.

Born in New York City in 1858, Charles Warren Hunt graduated from New York University in 1876 in civil engineering and immediately took up engineering work with the government on river and harbor work. Subsequently he was engaged in sewage disposal and water-supply work in the New York metropolitan district as assistant to the late Charles T. Brush and the late J. James R. Croes. In 1892, while engaged on elevated railway work in Brooklyn Mr. Hunt was appointed assistant secretary of the American Society of Civil Engineers. Three years later he was elected secretary of the society to succeed the late Francis Collingwood. His service as secretary continued for twenty-five years, until 1920, when at his own request on account of ill health he was relieved of active duty. The board of direction, thereupon, appointed him secretary emeritus at a salary of $6,000 with such duties as the board might assign to him.

During the 25 years that Dr. Hunt served as secretary of the society, the organization made remarkable progress. Its membership increased from 1,808 to 9,408, the project for the acquisition of the society's house on 57th St., New York, was consummated, the society publications were improved in volume and in form, the work of planning and administering the International Engineering Congress in St. Louis in 1904 was carried forward, largely under Dr. Hunt's direction, the cataloging of the society's library was begun and the making of "searches" in the library for non-resident members was inaugurated.

Major questions of society policy came up for determination during Dr. Hunt's administration. Among them the matter of participation in professional welfare and civic activities was one upon which Dr. Hunt took a definite stand which brought him much criticism. He opposed participation in such activities, maintaining that they should be handled by a separate society. His stand was accepted by the society and has been adhered to closely until quite recently. Dr. Hunt also opposed the infusion of commercial thinking into society activities at a time when other societies were leaning that way. Throughout his career as secretary his efforts were directed toward advancing the society's prestige and keeping the standards of its activities and its membership qualifications upon a high plane.

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WASHINGTON NOTES

By Paul Wooton
Washington Correspondent

The whole question of bank revetment is under study by the army engineers. If revetment is to be made most effective, it has been found, it will be necessary to increase its cost greatly, through the use of non-corrosive wire, thicker mats or by making the whole revetment more impervious to the action of the water. A possible alternative may be the use of heavy gravel as a substitute for willow and concrete. Dredging may play an important part in preventing ravages on the banks of the river.

This study is an essential part of the investigation being made as to the possibilities of increasing the discharge capacity of the Atchafalaya River and of the Mississippi between Arkansas City and Red River Landing. In that connection experiments are being conducted in the hydraulic laboratory at Vicksburg and experimental cutoffs are being dredged across two points below the mouth of the Yazoo River. The points were selected where no harm is likely to follow, regardless of the action of the river. Operations in the Atchafalaya River also are expected to produce results that will have a bearing on the recommendation that will be made to Congress in December in connection with the proposed straightening of the sector of the Mississippi River mentioned. No conclusions have been reached as to the recommendations that will be made as to changes in the flood control act.

Securities Examiner Authorized

The Federal Power Commission has received specific authority from President Hoover for the appointment of Sanford H. Brown to the position of securities examiner. This action is opportune by reason of the increasing attention which the reorganized commission is giving to the subject of the security issues of the licensee companies not regulated in this particular by state agencies.

The present action by the President completes the approval of the new activity of the power commission given by the budget and the appropriations committee of the House, and makes possible the continuance of the study by the power commission of this important phase of regulation in the interest of investor and customer alike.

Railroad grouping approved

After working for twelve years on its own plans, the Interstate Commerce Commission has accepted, almost in its entirety, the four-system consolidation plan for the eastern railroads put forward by the executives of the larger systems nearly two years ago with the implied approval of the President. Up until now the commission has favored a five-system consolidation plan.

New England roads are excluded, final disposition of them is reserved for further study. The remaining roads, with minor exceptions are assigned to four systems, the Pennsylvania, New York Central, Baltimore & Ohio, and the Chesapeake & Ohio-Nickel Plate. The principal roads not assigned are the Delaware & Hudson and the New York Ontario & Western. The D. & H. is left independent as a bridge line for the present and the N. Y., Ont. & W. is left assigned to the New Haven, as in the commission's plan for the entire country published in 1929.

Most of the 57,000 miles allocated by the commission's new plan already are either in one of the four systems or are controlled by the system to which they are assigned. Those not so controlled are largely terminal lines, bridge lines or short lines which are a liability rather than an asset.

The effect of the commission's decision is to put the stamp of approval on a set-up largely arranged by flouting its authority; but in one important instances, the Pennsylvania control of the New Haven and the Boston & Maine through holding companies, the commission requires that the railroad definitely divest itself of this control as a precedent to approval of its control of the Wabash and Norfolk & Western.

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Hoover Dam Notes

A cloudburst over the Hoover Dam area July 10 washed out the railroad trestle on the Six Companies line between Boulder City and Las Vegas. Considerable damage was done to the Boulder City-Las Vegas highway. The damage to the railroad made it necessary to suspend work for several shifts in the Arizona gravel deposit. In spite of that delay, 389 cars of gravel were shipped. The storm had little effect on the Colorado River which continued to fall during the week ended July 16. At the end of the week it was discharging at the rate of 29,000 sec.-ft. Cooler weather prevailed during the week after the storm.

* * *

At the mixing plant in Black Canyon a new record has been established with an output of 17,116 cu.yd. for the week.

* * *

Work was started July 15 on the open cut at the outlet of tunnel No. 4. Excavation was in progress throughout the week for the bulkhead structure at the inlet of tunnel No. 1. A jumbo equipped with 15 drills is engaged in drilling grout holes in tunnel No. 4.

* * *

At the end of the week under review Six Companies, Inc., and its subsidiaries were employing 2,750 men.

City-Manager Government Recommended for Reno

A city-manager system for the city of Reno, Nev., was recommended by the Washoe County Grand Jury in its preliminary report made public July 9. Members of the city council have announced that they will take steps to put the new system into effect.

Other recommendations of the grand jury included election of a city council of nine members which shall choose its own mayor; employment by city and county of only single women or married women whose husbands are incapacitated and unable to work and the removal of all taxi stands from the business district of Reno and establishment of a union depot for them.

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R.F.C. Procedure

(Continued from page 116)

several federal reserve districts where the corporation now retains loan agencies and financial advisory committees. The members of such regional boards probably will serve without compensation. It is expected that the regional boards will submit their recommendations on all applications to headquarters independently of the recommendations made by the corporation's financial advisers in the field.

The Corps of Engineers, the Bureau of Public Roads, the Supervising Architect and other federal agencies will continue to exercise, as at present, their supervisory authority over all projects coming within their jurisdiction.

There is no disposition in the R.F.C. to put a broader construction on the term "self-liquidating" than is applied in the law to projects proposed by states and municipalities and by private corporations. The provision for defraying the construction cost of publicly-owned bridges partly by tolls and the remainder by taxes imposed pursuant to state law already enacted, will apply so far as known, only to the projected bridge of the New Orleans Public Belt Railroad across the Mississippi. With respect to all other projects, recourse to taxation is foreclosed.

The law has been construed in some quarters as encouraging states and municipalities to engage in public utility enterprises but, as a practical matter, it will be very difficult for a municipality to convince the corporation that, if divorced from taxation, public electric, gas and other businesses will pay, or in the language of the law will be self-liquidating. It is certain that the R.F.C. will not make loans for the duplication of public utilities.

Major help for public projects

States and muncipalities, to the extent that they can satisfy the corporation as to the self-liquidating character of their projects, can obtain loans for a wider variety of projects than can private corporations, because the R.F.C. has no present intention of construing in other than a literal sense the types of projects listed in the law to which loans to private corporations are limited. A municipality, for example, may undertake both waterworks and sewage projects on a self-liquidating basis. A private corporation is eligible to a loan for waterworks but it is practically certain that this will not be defined to include sewers.

Pending official announcement by the corporation of its rules of procedure, the information presented below will serve applicants for loans.

Eligibility for loans

The Emergency Relief and Construction Act itself (*EN-R*, July 21, 1932, p. 88), in Section 201 (a), plainly lists the type of public or private corporation eligible for loans.

Loans may be made at any time prior to Jan. 23, 1934, for such periods as the corporation may approve, not exceeding ten years to corporations. Loans to states, muncipalities and other public instrumentalities may be made for a period exceeding ten years when it is the judgment of the board of directors of the corporation that it is necessary to purchase their securities and that it is not practicable to require the reimbursement of the corporation, within ten years, through the repurchase or payment of such securities, or in any other manner. The rates of interest or discount will be determined by the corporation.

Security for loans

The act provides that all loans made by the corporation must be fully and adequately secured. It also provides that no loans may be made upon foreign securities or foreign acceptances as collateral.

All loans under Section 201 (a) may be made directly upon promissory notes of the borrower or by way of discount or rediscount of obligations tendered for the purpose, or otherwise, in such amount and at such interest or discount rates as the corporation may approve, and in such manner as to impose upon the borrower an unconditional obligation to repay such loans in accordance with their terms. Loans to states, municipalities or other political subdivisions or their instrumentalities may be made by the purchase of their securities or otherwise, and for such purpose the corporation is authorized to bid for such securities.

Applications for loans

A form of application may be obtained, when prepared, from the corporation at Washington, D. C., or from any federal reserve bank or branch reserve.

Sufficient credit information should be submitted to enable the corporation to determine promptly the financial condition of the applicant and the reasonable value of the security offered. Collateral listed in the application must be considered and valued by the officers authorized to execute the application. False statements and overvaluations of such security are subject to the penal provisions of the act. If the applicant is a state, muncipality, public corporation or other public instrumentality, the application should state whether the bonds or other securities are offered as collateral or for purchase by the corporation on its bid or otherwise.

As to project information, applicants should present in appropriate form a description of the project contemplated accompanied by an engineering report setting forth the estimated cost of construction, prospective revenue under the method of self-liquidating proposed, the term within which it is expected that liquidation will be completed and other pertinent information.

Personals

Malcolm Elliott, major, Corps of Engineers, has been relieved from assignment at Juneau, Alaska, and assigned to duty in the office of Chief of Engineers, Washington, D. C.

C. D. Vail has been named chief engineer of the Colorado state highway department by the civil service commission.

Harry C. Billings, former assistant city engineer at Ontario, Calif., has been appointed city engineer and building inspector at Claremont, Calif. He was named to succeed Carl Taylor, who recently resigned.

C. C. Hommon has been restored to his position as superintendent of the Canton, Ohio, sewage treatment plant by the Canton city council. He had been removed early in March as a measure of economy.

R. D. Maclean has been appointed temporary city engineer of Niles, Ohio, succeeding the late **E. M. Milligan**.

Melvin O. Sylliaasen has been appointed city engineer of Seattle, Wash., and his appointment has been confirmed by the city council. Mr. Sylliaasen was graduated from the University of Washington in 1913 and was a member of the city engineer's staff for six years. For ten years he has been associated with John Graham, architect.

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Obituary

William Wolcott Tefft, vice-president of the Fargo Engineering Co., died in a hospital at Ann Arbor, Mich., on June 24. For some years Mr. Tefft had been a vice-president and chief engineer of the Commonwealth Power Corp.

Joseph F. Sullivan, secretary of the Street Commission of Boston, died of a heart attack on July 20, age 61. He had been in the service of the city of Boston since 1898 and had been secretary of the Street Commission since 1918. He was the author of a volume dealing with the legal aspects of highway condemnation and benefit assessments.

John T. Robertson, chief engineer of the Consolidated Water Co. of Utica, N. Y., and president of the Mohawk Valley Engineers Club, died suddenly on July 24 while playing golf on the Valley View Links at Utica. He was born in Bristol, R. I., July 4, 1884, and came to Utica in 1917 as assistant engineer of the Consolidated Water Works. Ten years later he was made chief engineer.

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SOCIETY CALENDAR

NEW ENGLAND WATER WORKS ASSOCIATION, annual meeting, Springfield, Mass., September 27-30.

AMERICAN PUBLIC HEALTH ASSOCIATION, annual meeting, Washington, D. C., October 24-27.

AMERICAN ASSOCIATION OF ENGINEERS will hold its 18th Annual Convention at the Shoreham Hotel in Washington, D. C., on September 26 to 28.

INTERNATIONAL CITY MANAGERS ASSOCIATION and GOVERNMENTAL RESEARCH ASSOCIATION will hold a joint annual conference at Cincinnati, Ohio, on October 24 to 26.

INTERNATIONAL ASSOCIATION OF PUBLIC WORKS OFFICIALS will hold its annual conference at Pittsburgh, Pa., Sept. 29-Oct. 1.

Engineering Contracts and Capital

Heavy engineering construction contracts reported the past week total $29,331,000. Private work, however, was the smallest yet reported this year, amounting to $1,911,000. The weekly average of contracts awarded during July is $30,127,000, a considerable increase over the 23-million-dollar average for June, but still far behind the July, 1931, average of 49 millions. The value of all contracts for heavy work reported to date this year is $719,039,000, or 58 per cent below the 1931 total of $1,729,592,000.

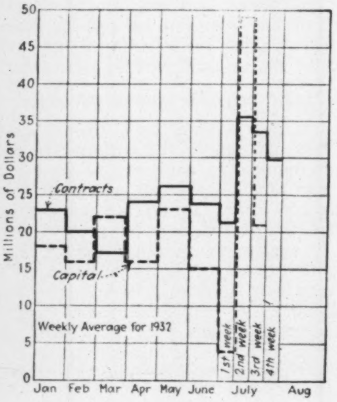
Large contracts reported the past week include Mississippi River levee and protection work amounting to over $8,000,000, a municipal auditorium at St. Louis to cost $3,162,000, an addition to the St. Louis post office, $4,250,000, and Ohio state highway awards totaling $1,500,000.

Steel Output Improves—Steel output has slowly crawled up to 16 per cent of capacity after falling to an all-time low of 11 per cent earlier in the month. Encouragement is seen in the report of ending of price concessions formerly enjoyed by special customers. Increase in activity in steel mills is found in both the Pittsburgh and Youngstown areas.

Highway Mileages—Illinois has completed 520 miles of new road construction, according to Frank Sheets, state highway engineer. Of this amount 277 miles was for extension of the state bond issue system and 243 miles represents county highway construction. In early July 6,950 men were directly employed on road work in Illinois.

Up to July 19, New York state had completed 199 miles of highways this year, involving 2,495,380 sq.yd. of paving. On this date contractors were using 6,760 men directly on road work, and the state had an additional 5,459 on the maintenance payroll.

Building Costs Down—According to a recent survey made by the New York Building Congress, building costs in New York have dropped 35 per cent since 1925, the peak year in costs. The factors considered in the survey are materials, labor, overhead and profit, with no attempt being made to include land values or financial carrying charges. The recent downward revision of wage scales in New York was considered. The congress warns that this survey covers a limited field only in the metropolitan area. The *ENR* cost index of all construction shows a 26-per cent drop from the average of 1925.



Minnesota Road Employment Heavy—In the rush to bring to completion before cold weather the large program of the Minnesota state highway department, more than 13,000 men are being employed. Recent lettings are expected to call for an additional 1,500 workers. At present 8,500 are employed by contractors and 4,800 by the state. The schedule for the year's work includes 450 miles of new paving, 1,000 miles of new bituminous treatment, 1,065 miles of retread and considerable graveling and bridge work.

Baltimore to Drop Workers—One thousand per diem workers in the city of Baltimore will be dropped soon to avert a deficit in the city's allotment for their services, according to Mayor Jackson. The majority of these have been employed by the department of public works.

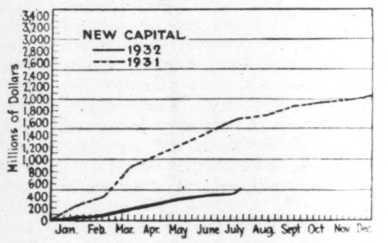
Contracts and Capital

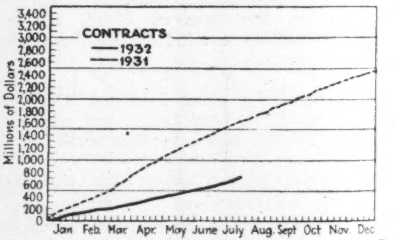
CONSTRUCTION
(Thousands of Dollars)

	Weekly Average July, 1931	Weekly Average July, 1932	Week July 28, 1932
Federal government...	$4,512	$11,176	$13,5[illegible]2
State and municipal...	25,245	11,962	13,7[illegible]8
Total public........	$29,757	$23,138	$27,420
Total private.......	19,265	6,989	1,911
Week's total.......	$49,022	$30,127	$29,331
Cumulative, Jan. 1 to date:			
1931 construction....................			$1,729,592
1932 construction....................			719,039
Decrease, 58 per cent.			

NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

	Weekly Average July, 1931	Weekly Average July, 1932	Week July 3, 193[illegible]
Total private and public	$41,500	$25,300	$22,000
Cumulative, Jan. 1 to date:			
1931 new capital....................			$1,589,500
1932 new capital....................			510,000
Decrease, 69 per cent.			





ENR Cost and Volume Index

Cost		Volume	
July, 1932......	**153.36**	**June, 1932**......	**131**
June, 1932.......	152.20	May, 1932.......	149
July, 1931.......	174.37	June, 1931.......	243
1931 (Average)..	181.35	1931 (Average)...	220
1930 (Average)...	202.85	1930 (Average)...	260

1913 Average........ 100.00

Construction Equipment and Materials

Concrete Paving Tamper

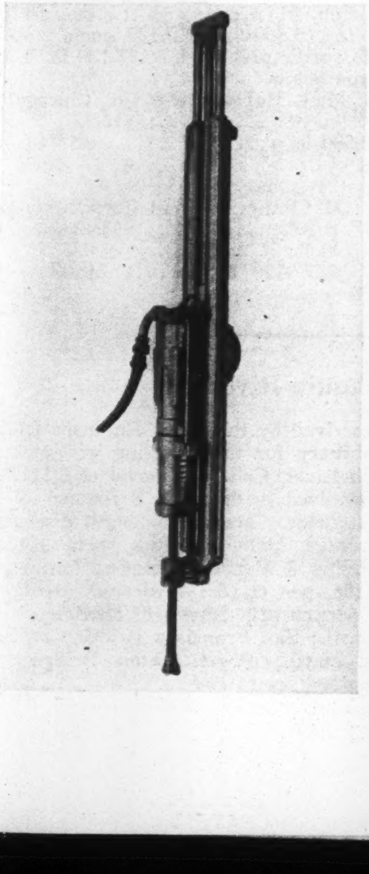
The Lakewood form tamper, a machine specially designed to take care of the tamping required under the forms in concrete paving work, is announced by the Lakewood Engineering Co., Columbus, Ohio. It is a small portable unit that can be handled by one man. Once started, it will run on the forms without further attention until stopped. It also oils the inside face of the forms. It is adjustable as to base and height of forms and is provided with tampers operating on both sides of the forms at the base.

Lakewood form tamper.

Pneumatic-Feed Rock Drill

A twin-cylinder pneumatic-feed rock drill, designated as class A-5 is announced by the Sullivan Machinery Co., Chicago, Ill. The pneumatic feed consists of two parallel feed cylinders, containing pistons and piston rods, which terminate at their upper ends in a special yoke or cross-head. This cross-head also receives the rear end of the connecting rod running into the back head of the drill. Two drilled holes in the connecting rod connect with separate passages in the drill head and in the cross-head at the rear end. By this means live air is delivered to either the rear or front side of both feed pistons as desired. The throttle valve of the drill controls the air supply to the drill mechanism and also that to the two passages in the back head of the drill to secure forward or reverse feed on its mounting. A spring-loaded valve, with hand-adjusting screw, controls the amount of air pressure supplied to the advance feed and is in effect an adjustable pressure regulator to control the feed for best operation in the structure being drilled. Among the advantages claimed for this new device by the manufacturer are the elimination of feed screws and hand-cranking, the avoidance of shanking for broaching steel, adaptability to varying rock conditions, single-throttle control of both drill and feed, and the automatic-feed regulation.

Twin-cylinder pneumatic-feed drill.



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New Equipment in Brief

Drum and Capstan Car-Puller—A combination drum and capstan car-puller for starting a train of loaded railroad cars in either direction and at a slow rope speed is announced by the Fridy Hoist & Machinery Co., Mountville, Pa. The new machine is furnished in 7½-, 10-, 15- and 20-hp. motor ratings for spotting a train of 500 tons and less. It includes an asbestos-lined friction clutch. The improved type of screw thrust assures a positive grip and release of the drum by a slight movement of the operating lever. A triple-spur gear drive is furnished in steel and inclosed in an iron housing.

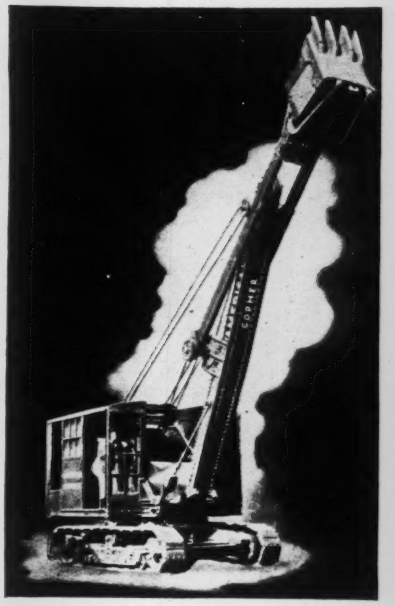
Dustless Floor Sander—The Porter-Cable-Hutchinson Corp., Syracuse, N. Y., announces their new dustless edger, a portable motor-driven belt sander. The sanding belt runs over a pulley covered with flexible rubber, a feature that the manufacturer claims greatly lengthens the life of the belt. Dust is removed by a vacuum created just behind the belt caused by a motor-driven fan. The dust is deposited in a cloth bag. The motor of the new machine develops 1 hp. and can be operated from an electric-light socket.

Gear-Sealing Process—The Caterpillar Tractor Co., Peoria, Ill., has placed in production a gear-sealing process to protect the drive gear in the rear end of a tractor from dust, mud and grit. It involves a combination of hardened washers and spring-loaded cork gear housings. The process is being used on most of the new tractor models now in production.

Autocar Truck—The Autocar Co., Ardmore, Pa., announces their new Model R 1½-ton truck. It is a six-cylinder dual-rear-wheel truck with standard wheelbases of 159, 171 and 189 in. Its gross weight is 14,000 pounds.

Shovel-Crane Dragline

The American Hoist & Derrick Co., St. Paul, Minn., is offering a new model "American Gopher" shovel-crane dragline, gasoline or diesel-engine operated. The new machine comes in five sizes having capacities of ¾, 1, 1¼, 1½ and 1¾ yd., respectively. They are all mounted on continuous-chain crawler treads.



New Machine of American Hoist & Derrick Co.

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Business Notes

Medusa Products Co., Engineers Building, Cleveland, Ohio, has been organized as a subsidiary of the Medusa Portland Cement Co. to function as the selling company for Medusa Portland Cement Paint, Medusa floor coating and primer, as well as the entire line of rustproof coatings and technical paints manufactured by the Studebaker Chemical Co., of Elyria, Ohio, for which it will be exclusive distributor.

Northwest Engineering Co., 28 East Jackson Blvd., Chicago, Ill., announces the appointment of R. W. Cornelisen as field sales manager.

Austin Manufacturing Co., of Chicago, Ill., announces the election of S. F. Beatty as president. Mr. Beatty has been president of the Austin-Western Road Machinery Co. and of the Road Machinery Manufacturers Association. He has also been an officer and director of the American Road Builders Association. Mr. W. T. Beatty, for many years president and general manager of the Austin Manufacturing Co., has been elected chairman of the board, while K. N. Forbes has been elected vice-president.

The United States Steel Corp. has recently negotiated a contract with Edward G. Budd Manufacturing Co., through which it has acquired the rights to the Budd system of stainless steel construction, including its shot-welding processes for the use of its subsidiaries in the construction of ships, bridges and structural elements in buildings.

Flint Rock Co., Ingomar, Ohio, has appointed the Neff & Fry Co. of Camden, Ohio, as its distributor. Hereafter the Flint Rock Co. will devote all its attention to manufacturing.

The Farval Corp., 3277 East 80th St., Cleveland, Ohio, has recently acquired the manufacturing and sales rights of the Farval centralized system of lubrication. This equipment was formerly manufactured by Lubrication Devices, Inc., Battle Creek, Mich.

The Kron Co., Bridgeport, Conn., manufacturers of industrial scales, has appointed G. P. Blackiston sales-promotion manager.

Current Construction Unit Prices

Concrete Shoulders and Roadway, Maryland

CONTRACT WAS let in June for the construction of 3.34 miles of concrete shoulder and roadway along the Generals Highway in Anne Arundel County, Maryland. Eight bids were submitted, contract going to the low bidder, P. Reddington & Sons, Baltimore, for $58,189. The high bid was $67,773. The following tabulation gives the unit prices on main items of the low bidder and the average of all eight bidders. G. Clinton Uhl is chairman of the State Roads Commission of Maryland.

Item	Quan.	—Unit Contr.	Prices— Ave.
Excavation, cu.yd.	42,950	$0.19	$0.236
Borrow, cu.yd	4,500	.18	.247
Concrete base course, sq.yd.	1,350	.87	1.08
Concrete pavement, 9 in., sq.yd.	11,700	1.09	1.03
Concrete pavement, 8 in., sq.yd.	1,800	1.00	1.15
Concrete shoulders, sq.yd	5,350	1.32	1.31
Concrete, class A, cu.yd	555	11.75	12.12
Concrete, class B, cu.yd	543	7.80	8.40
Reinforcing steel, lb	99,650	.0375	.0357
Corr. metal pipe, 12 in., ft	344	1.10	1.10
Cast iron pipe, 30 in.	175	6.00	5.83
Concrete gutter, 8 in., sq.yd	1,310	1.36	1.36
Wire rope guard fence, ft	5,840	.44	.41
Timber piles, class B, ft	10,000	.25	.43
Wet excavation, cu.yd.	675	1.25	1.44
Total		$58,189	$62.544

Three Dredging Contracts, New Jersey

THE BOARD of Commerce and Navigation of the state of New Jersey awarded three dredging contracts in June to the Hill Dredging Corp., Ventnor, N. J. The three projects are as follows: Forked River, Ocean County, 131,461 cu.yd., contract price $22,024; Cape May County, 280,551 cu.yd., contract price $16,553; Inland waterway channels in Gull Island Thorofare, Reeds Bay and Grassy Bay, Atlantic County, 212,606 cu.yd., contract price $26,554. Victor Gelineau is director of the Board. Unit bid prices follow.

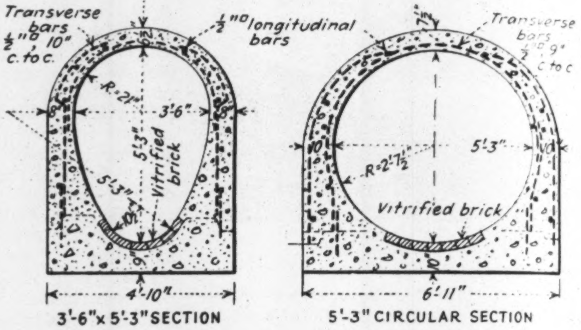
FORKED RIVER PROJECT	
Hill Dredging Corp., Ventnor, N. J.	$0.1675
C. Walker Hodges Dredging Co., New Bern, N. C.	.2955
Sanford & Brooks Co., Baltimore	.30
The Arundel Corp., Baltimore	.34
Thos. Proctor Co., Long Branch, N. J.	.48
CAPE MAY PROJECT	
Hill Dredging Corp., Ventnor, N. J.	$0.059
Delaware Dredging Co., Philadelphia	.0888
American Dredging Co., Philadelphia	.102
Standard Dredging Co., New York	.114
Sanford & Brooks Co., Baltimore	.123
P. Sanford Ross, Inc., Jersey City	.1528
The Arundel Corp., Baltimore	.213
INLAND WATERWAY PROJECT	
Hill Dredging Corp., Ventnor, N. J.	$0.1249
C. Walker Hodges Co., New Bern, N. C.	.1398
Delaware Dredging Co., Philadelphia	.14
Sanford & Brooks Co., Baltimore	.149

Concrete Sewers, San Francisco

CONTRACT FOR monolithic concrete sewers, 1,600 ft. of 5ft.3in. circular and 1,799 ft. of 3ft.6in.x5ft.3in. egg-shaped, in Fillmore St. was awarded by the city of San Francisco in June. One taper connection, twenty manholes, four junctions and considerable underdrains were included in the work. The sewer occupies the center of the street and has from 5 to 10 ft. of cover. The contract was let to Macdonald & Kahn for $69,858. Engineers' estimate was $77,693. A low bid of $56,858 was evidently not considered. The average of ten bids submitted was $80,140. The following table gives main unit prices of the contract (A), average of second, third and fourth low bids (B) and engineers' estimate (C). John J. Casey is city engineer.

Prevailing labor rates of principal trades, which must be paid by contractor, has been determined as follows: Bricklayers, $11; hod carriers, $7; carpenters, $9; cement finishers, $9; common laborers, $5.50; shovel operators, $10; truck drivers, $6 to $8.50; all based on an 8-hour day.

Item	Quan	—Main A	Item Unit B	Prices— C
Conc. sewer, 5 ft. 3 in. circ., ft.	1,600	$19.53	$20.86	$24.30
Conc. sewer, 3 ft. 6 in. x 5 ft. 3 in., ft.	1,799	16.90	17.22	16.65
Conc. sewer, 3 ft x 4 ft. 6 in., ft.	153	17.10	18.17	15.75
Underdrain, 6 in., per ft	1,840	0.12	0.41	0.54
Total		$69,858	$72,896	$77,693



Sections monolithic concrete sewers, Fillmore St., San Francisco. Quantities per lin.ft.: Concrete—circular, 19.1 cu.yd.; oval, 14.95 cu.yd. Steel—circular, 44.3 lb.; oval, 29.4 lb.

Steel Overhead Crossing, Cook Co., Ill.

CONTRACTS for a 2,719-ft. deck plate girder overhead crossing over the Santa Fe R.R. and the Des Plaines River at Justice, Ill., were awarded in March, 1932 by the Illinois department of public works and structures. Superstructure consists of the following deck plate girder spans: one, 64 ft.; eight, 99 ft.; fourteen, 91 ft.; six, 83 ft.; one, 91 ft. Quantities are: concrete, (3,500 lb.) 10,329 cu.yd.; reinforcing steel, 835,370 lb.; structural steel, 8,177,130 lb. Unit contract prices are given below.

Sec. B, substructure: M. J. McDermott & Co., Chicago.
Concrete,* 7,392 cu.yd. $13.23
Reinf. steel, 310,580 lb. .... .02
*Cement furnished

Sec. C, superstructure: McClintic Marshall Corp., Chicago.
Concrete,* 2,937 cu.yd. $13.40
Reinf. steel, 524,790 lb. .... .023
Structural steel, 8,177,130 lb. ...... .0287
*Cement furnished

Dredging San Joaquin River

FIVE BIDS were received by the U. S. Engineer Office, Sacramento, in February for the dredging of Stockton channel in San Joaquin River, Calif. Removal of 3,111,000 cu.yd. of material is involved in dredging a channel 26 ft. deep and 100 to 110 ft. wide. Maximum length discharge lines is 6,000 ft., average 3,000 ft. Bids were as follows: Longview Dredging & Construction Co., Longview, Wash., (contract) 7.25c. per cu.yd.; Hydraulic Dredging Co., Oakland, 7.47c. per cu.yd.; Standard Dredging Co., Oakland, 7.59c. per cu.yd.; San Francisco Bridge Co., San Francisco, 7.68c. per cu.yd.; Puget Sound Bridge and Dredging Co., Seattle, 8.89c. per cu.yd.